



## A multivariate dynamic linear model for early warnings of diarrhea and pen fouling in slaughter pigs

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THE FACULTY OF HEALTH AND MEDICAL SCIENCES  
UNIVERSITY OF COPENHAGEN

CENTER FOR RESEARCH IN PIG PRODUCTION  
AND HEALTH



Book of presentations of the 3<sup>rd</sup> CPH Pig seminar  
February 3, 2016

## Up to Date with Pig Research



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## Preface

The Center for research in pig production and health – CPH Pig – enhances, consolidates and raises the profile of pig production research. The importance of research and innovation for the Danish pork industry remains crucial. The Danish pig producers face tight financial pressures and many factors contribute to the volatility surrounding the pork industry. The production of finishers in Denmark is declining as producers export a significant and increasing number of weaners to be finished elsewhere in Europe. A goal of CPH Pig is, in collaboration with its many partners, to support the Danish pig industry with R&D that is essential in addressing drivers of a profitable and sustainable pork production in a global market.

The 2016 seminar presents the recent developments across a diverse range of disciplines impacting on pig production particularly on increased productivity, survival among piglets, MRSA, reduction in antibiotic usage and objective measurements of animal welfare. With this in mind, the research presentations of the CPH Pig seminar will cover four main themes: “Growing pigs”, “Sows and Piglets”, “Welfare” and “MRSA”. It is our hope that this third CPH Pig seminar will provide an excellent forum to present new findings, foster in-depth discussions, and hopefully provide solutions to some of the industry’s challenges.

The University of Copenhagen and CPH Pig are integral in the training of undergraduate and postgraduate students and generating junior scientists who are essential to the future of the industry. CPH Pig outwardly promotes the involvement of students and early-career scientists at the meeting. The seminar again has a considerable number of young scientists attending and presenting their work and for many it will be their first opportunity to interact with key industry figures and organisations.

It is a pleasure to direct the CPH Pig seminar and contribute to facilitating the networking of those involved in pig research and pork production. This seminar is possible because a dedicated group of individuals coordinated and arranged all aspects of the event. We wish to thank everyone for their contribution and dedication. However, most importantly, thank you for participating and making the seminar a great success. Thank you for your support and we hope you will continue to be part of the future achievements of the center.

Hans Henrik Dietz  
*Chairman*

Christian Fink Hansen  
*Center Director*

## Programme

### CPH Pig Seminar February 3, 2016 Up to Date with Pig Research



Time	Presenters	Title
9:00-9:10	Hans Henrik Dietz Head of Department, Department of Large Animal Sciences, University of Copenhagen	Welcome
9:10-9:30	Jens Ulrich Nielsen Director, Innovation, SEGES Pig Research Centre	Key Lecture: Benefits of linking universities and the Danish pig industry – from the industry's point of view
<i>Session 1: Growing pigs</i>		<i>Chair: Jens Peter Nielsen</i>
9:30-9:45	Gitte Blach Nielsen, Industrial PhD student, Department of Large Animal Sciences, University of Copenhagen & MSD Animal Health	PCV2 infection dynamics: Diagnostics, between-batch consistency and correlation to productivity parameters
9:45-10:00	Dan Børge Jensen, PhD student, Department of Large Animal Sciences, University of Copenhagen	A multivariate dynamic linear model for early warnings of diarrhea and pen fouling in slaughter pigs
10:00-10:15	Louise Kruse Jensen Assistant Professor, Department of Veterinary Disease Biology, University of Copenhagen	Osteomyelitis in Danish slaughter pigs
10:15-10:30	Anna Helena Stygar, Post doc., Department of Large Animal Sciences, University of Copenhagen	Monitoring growth in finishers by weighing selected groups of pigs
<b>10:30-11:00 MORNING TEA/COFFEE</b>		
<i>Session 2: Sows and Piglets</i>		<i>Chair: Anne-Helene Tauson</i>
11:00-11:15	Ana Carolina Lopes Antunes PhD Student, DTU National Veterinary Institute	Monitoring PRRS using laboratory data
11:15-11:30	Sophie Van Vliet PhD student, Aarhus University	Impact of feeding regime on growth in prepubertal gilts
11:30-11:45	Thomas Sønderby Bruun, Senior Specialist, SEGES Pig Research Centre	Increasing the dietary level of protein for lactating sows affects litter gain and sow weight loss
11:45-12:00	Charlotte Amdi Williams, Post doc., Department of Large Animal Sciences, University of Copenhagen	Gastric emptying rate and blood values in newborn intra-uterine growth restricted piglets
<b>12:00-13:00 LUNCH</b>		

<i>Session 3: Welfare</i>		<i>Chair: Björn Forkman</i>
13:00-13:15	Karl Johan Møller Klit PhD student, Department of Large Animal Sciences, University of Copenhagen	The use of virtual herds in veterinary and agricultural education
13:15-13:30	Marlene Kirchner Assistant Professor, Department of Large Animal Sciences, University of Copenhagen	Assessing farms with the Danish animal welfare index
13:30-13:45	Helle Pelant Lahrmann Industrial PhD student, Department of Large Animal Sciences, University of Copenhagen & SEGES Pig Research Centre	Tail biting: prevalence among docked and undocked pigs from weaning to slaughter
13:45-14:00	Janni Hales Pedersen Post doc., Department of Large Animal Sciences, University of Copenhagen	Loose housed sows with low piglet mortality
<b>14:00-14:30 AFTERNOON TEA/COFFEE</b>		
<i>Session 4: MRSA</i>		<i>Chair: Anders Miki Boyesen</i>
14:30-14:45	Julie Elvekjær Hansen PhD student, DTU National Veterinary Institute	Levels of MRSA on pigs and environmental samples
14:45-15:00	Carmen Espinosa-Gongora Post doc., Department of Veterinary Disease Biology, University of Copenhagen	Can we reduce MRSA ST398 in positive farms by eliminating a few pig carriers?
15:00-15:15	Anna Camilla Birkegård PhD student, DTU National Veterinary Institute	How to pool fecal samples in a cross-sectional study of antimicrobial resistance genes in Danish pig herds
15:15-15:30	Nicolai Weber, PhD student, Department of Large Animal Sciences, University of Copenhagen	Can pooled faecal samples be used for resistance profiling? -Resistance in <i>E. coli</i> isolates from diarrhoeic nursery pigs?
15:30-15:35	Christian Fink Hansen Professor, Department of Large Animal Sciences, University of Copenhagen	Concluding remarks



[www.cphpig.ku.dk](http://www.cphpig.ku.dk)

## List of participants

Amanda Brinch Kruse	PhD student, University of Copenhagen
Anja Annine Haagaard	DVM, Veterinarian
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Mette Klarlund	Student, Veterinary medicin
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Rikke Olsen	Assistant professor, Copenhagen University
Rikke Søgaard	Dyrlæge, Hipra Danmark
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Sofie Kromann	Stud.Med.Vet, KU
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Vibe Pedersen Lund	Research Assistant, University of Copenhagen
Vivi Aarestrup Moustsen	Senior Scientist, SEGES Pig Research Centre



Key Lecture: Benefits of linking universities and the Danish pig industry –  
from the industry's point of view

By Jens Ulrich Nielsen, Director, Innovation, SEGES Pig Research Centre

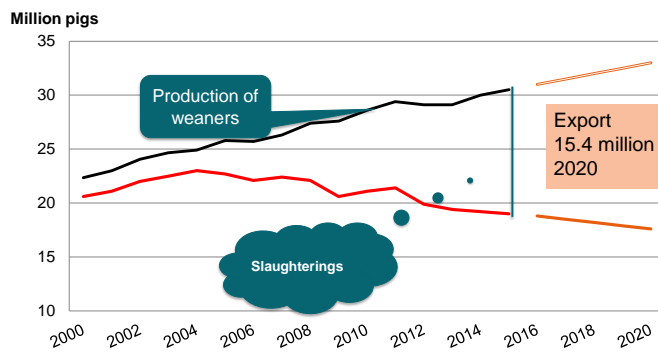


## BENEFITS OF LINKING UNIVERSITIES AND THE DANISH PIG INDUSTRY – FROM THE INDUSTRY'S POINT OF VIEW

SEGES Pig Research Centre  
Jens Ulrich Nielsen, Director, Innovation

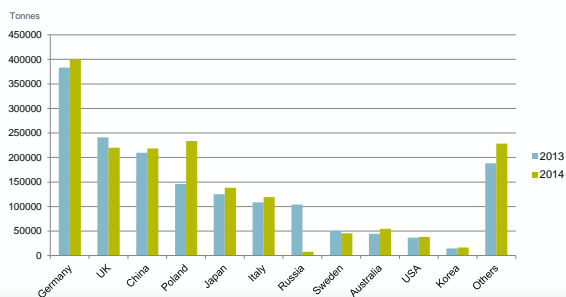


## PRODUCTION OF PIGS IN DENMARK

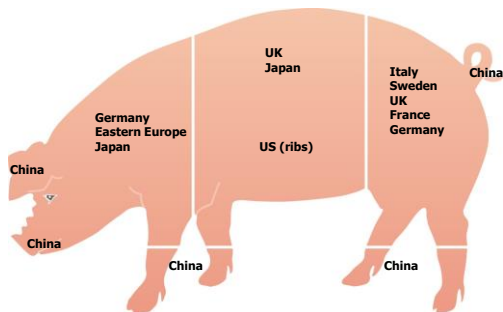


## Danish pork exports

THE DANISH  
STANDARD

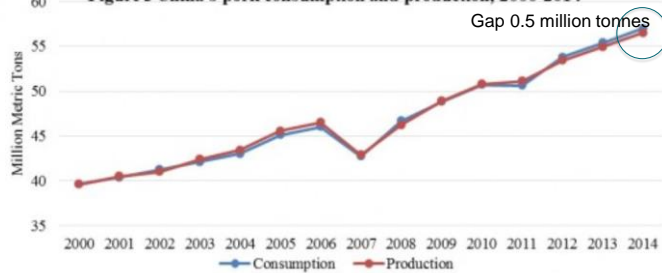


## Global exports – no leftovers



SEGES  
No leftovers

Figure 3 China's pork consumption and production, 2000-2014



Source: USDA Foreign Agricultural Service

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SEGES  
No leftovers

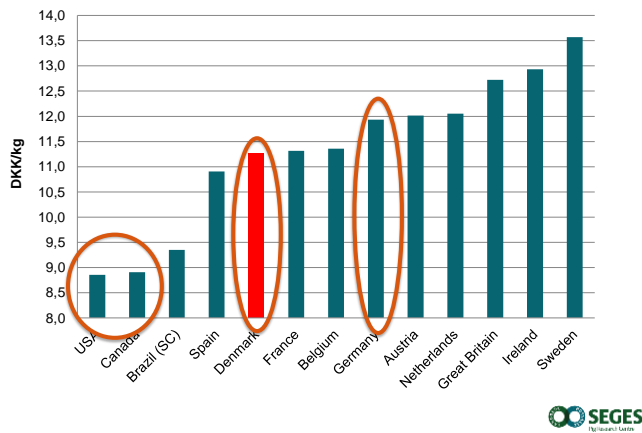
## CONSUMER PRIORITIES



6

SEGES  
No leftovers

## COST PER KG CARCASS 2014



## NEW PRODUCTION METHODS BASIS OF ADDED VALUE IN THE FUTURE

- Digitalization of the entire value chain
- Data/Realtime data as the basis of documentation, production monitoring, decision support, benchmarking
- Emission-based environment and climate production
- Biotechnology (biogas, ethanol, new protein sources etc.)
- Cost-efficient environmental technology
- Production concepts adapted to pig producers' conditions and to the future structure



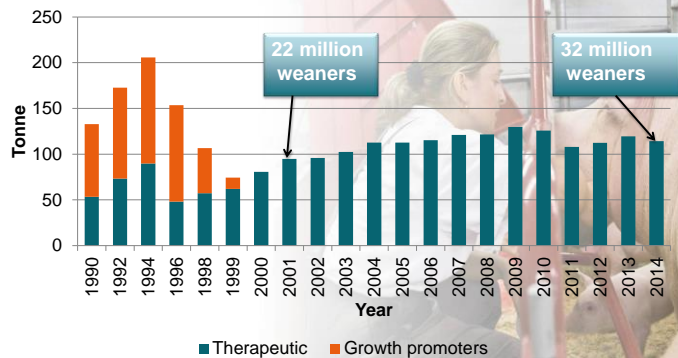
SEGES  
The Danish Group

## NEW URGENT NEEDS FOR RESEARCH

- Big data
- Data-driven innovation
- Internet of things in production technology
- Reduction in use of antibiotic and zinc



## ANTIBIOTIC USE FOR PIGS



## ZINC AND COPPER IN SLURRY AND SOIL

Report from DCE - Danish Centre for Environment and Energy  
 Significant increase in zinc levels in soil  
 Risk of future environmental and health problems  
 Minister for the Environment and Food: more research necessary  
 Supports reduction based on scientific grounds  
 Research in reduction of zinc in feed  
 Research in antibodies



Research

University

**COOP HAS  
BEEN AND WILL  
BE THE KEY TO  
SUCCESS**

Innovation



DIRECT  
information  
(Congress, seminars,  
website etc.)

Advisors

DLBR  
(Danish Agricultural  
Advisory Service)

Vet  
Practices

Companies  
(slaughterhouses,  
feedstuffs, farm  
technology etc.)

Pig producers



## DANISH PIG RESEARCH CENTRE

- Financed by Danish pig farmers
- 160 employees
- Responsible for research and development programmes and knowledge transfer to the Danish pig industry
- Support the development of a responsible and economically sustainable pig industry with the highest possible level of welfare and a minimum impact on the environment
- Trials for 15 million Euro annually
- Operate on 200 commercial farms




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## STRONGHOLDS IN COOPERATION WITH THE UNIVERSITIES

- Ensure that the industry benefits from research
- More relevant pig research
- Involvement of central qualifications
- Improve credibility and validation of SEGES PRC's work
- Access to more funds
- Knowledge transfer to the industry
- Supplementary training of employees
- Recruitment of new employees
- Mutual uality assurance
- Most recent knowledge included in education

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## MANY CHALLENGES - LOTS OF RESEARCH

WE ARE LOOKING FOR ANSWERS AND SOLUTIONS, NOT COSTS

sows with gastric ulcers

Routine tail docking

Environmental impact

Castration

MRSA

High sow mortality rates

Antibiotic use

**Thank you**




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## Session 1: Growing Pigs

PCV2 infection dynamics:  
Diagnostics, between-batch consistency and correlation to productivity  
parameters

By Gitte Blach Nielsen, Industrial PhD student, Department of Large  
Animal Sciences, University of Copenhagen & MSD Animal Health



UNIVERSITY OF COPENHAGEN
Faculty of Health and Medical Sciences


## PCV2 infection dynamics: Diagnostics, between-batch consistency and correlation to productivity parameters

### Preliminary results

CPH Pig February 3rd 2016

**Gitte Blach Nielsen**  
Industrial PhD student, DVM, Certificate in Swine Health and Management  
Department of Large Animal Sciences, Section for Animal Welfare and Disease Control  
MSD Animal Health, Swine  
[gitte.blach.nielsen@merck.com](mailto:gitte.blach.nielsen@merck.com)  
Supervisors: Hans Houe, Jens Peter Nielsen, John Haugegaard

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## Background

Porcine circovirus, type 2 (PCV2) known worldwide as a cause of reduced productivity in growing pigs

'Not killing pigs for diagnosis' – blood samples 'golden standard'

Impact of infection: Level of viremia in serum by PCR-analysis

Oral fluid sampling – quick, more animals, welfare

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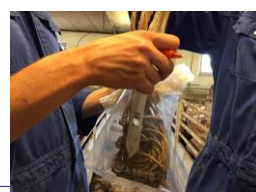

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## Research questions

Does level of PCV2:

- Correlate between serum and oral fluid ?
- Vary between batches in the same herd ?
- Correlate to productivity parameters and antibiotic usage ?

Sub-dataset from vaccination field trial  
Only non-vaccinated pigs included – vaccination influences PCV2 level

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## Study design

1 finishing herd 'Blue SPF' – highest health status

14 batches included (arriving 2 weeks apart), 2-5 pens sampled in each:  
 4 blood samples per pen -> 1 pool for PCV2-PCR-analysis  
 2 cotton ropes for oral fluid collection per pen -> 1 pool for PCV2-PCR-analyse

PCV2-PCR at DTU-Vet. -> 'viral copies per ml sample' on a log(10)-scale

**Timeline**

The same 4 pigs bled at consecutive sampling time points  
 – unless removal due to death or disease had occurred

MSD Animal Health

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## Results

Totally, 65 pens sampled 4 times = 260 serum/oral fluid pairs

*Results are not published yet and therefore omitted*

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## Diagnostics

– serum and oral fluid correlations

*Results are not published yet and therefore omitted*

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## PCV2 infection dynamics within batch

### Timeline

Arrival  
30 kilos

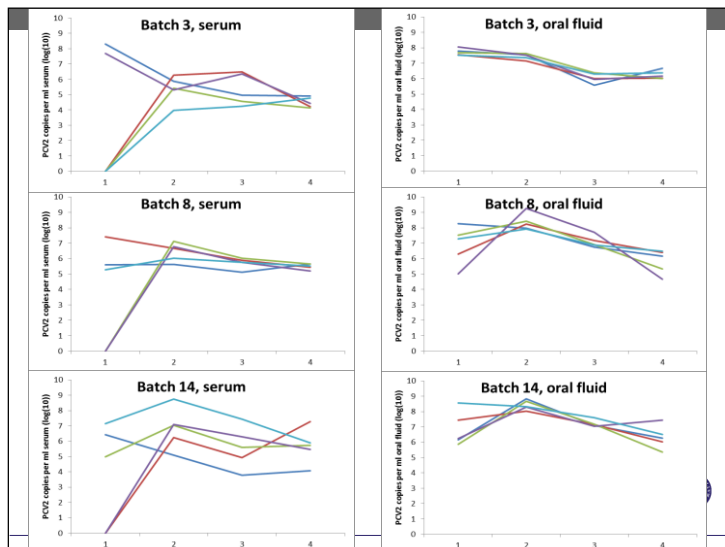
2 weeks

1. 3 weeks

2. 3 weeks

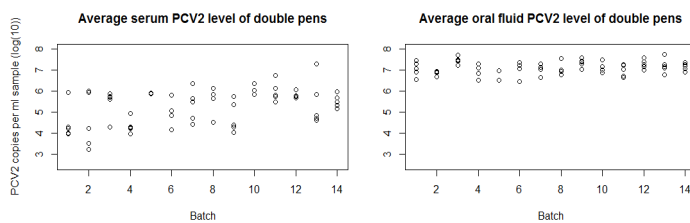
3. 3 weeks

4. Slaughter  
110 kilos



## Between-batch consistency

Viremia over time ~ average of the 4 time points



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## Correlations – PCV2 level and other parameters

*Results are not published yet and therefore omitted*

MSD Animal Health

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## Key points for the pig industry

Based on the results from this study:

Oral fluid sampling seems to be a relevant alternative to blood sampling

- The prevalence of positives was higher
- The level was higher

Serum level differed between batches (sections) within a herd,  
oral fluid level did not

PCV2 level was positively correlated to mortality and antibiotic usage

MSD Animal Health

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A multivariate dynamic linear model for early warnings of diarrhea and pen  
fouling in slaughter pigs

By Dan B. Jensen, PhD student, Department of Large Animal Sciences,  
University of Copenhagen

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Department of Large Animal Sciences


**A multivariate dynamic linear model for early warnings of diarrhea and pen fouling in slaughter pigs**

Dan B. Jensen  
daj@sund.ku.dk

Centre for **Herd-oriented Education, Research and Development**,  
Department of Large Animal Sciences, University of Copenhagen

**HERD** CPH PIG 2015 Dias 1

**PigIT**




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Department of Large Animal Sciences

**(Early) warnings – what's the point?**

**1. So many pigs, so little time!**

- A modern farm typically contains **thousands of pigs**
- Health is assessed by farm staff walking through the herd
  - Problems are **easy to miss**

**2. Sensors: always vigilant!**

- 24/7 sensor monitoring combined with detection algorithms
- Identification of high risk pens:
  - focused attention**
  - Proactive response**

**3. We need to know what to look for!**

- Some data are more valuable than others

**HERD** CPH PIG 2015 Dias 2

**PigIT**

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**In Conclusion**

**Take Home Messages**

- Automatic detection** and early warnings can help the farmers **focus their attention** on high risk pens
- Drinking behavior** and **Temperature** hold the most useful information for predicting diarrhea and pen fouling
- Different data** types might be best exploited in **different ways** (e.g. summaries vs. modeling)

**Acknowledgements:**  
Council for Strategic Research  
Pig Research Center (VSP)  
The technical staff at Aarhus University

**HERD** CPH PIG 2015 Dias 9

**PigIT**

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**Materials and methods:**  
**Multivariate Dynamic Linear Model**

**– a Quick Introduction**

**1. Features:**

- Dynamic, *i.e.* Adaptive
- Provides one-step-ahead forecasts
- Multivariate: co-variances are considered!

**2. Usefulness:**

- Monitoring of (production) systems over time

**3. Multiple variables → multiple forecast errors:**

- Forecast error unification (Cholesky decomposition/transformation)
  - I call it the **DLM/Cholesky method**

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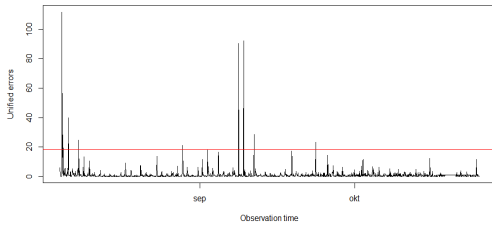
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**Results:**  
**Unified forecast errors**

Healthy batch  
 Unified forecast errors



Adjusting SE and SP:  
 How many consecutive alarms for one full alarm?

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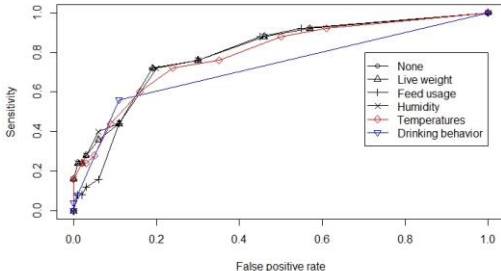
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**Results:**  
**Performance evaluation**

ROC  
 given omission of variables



Prediction window:  
 -3/+1 days

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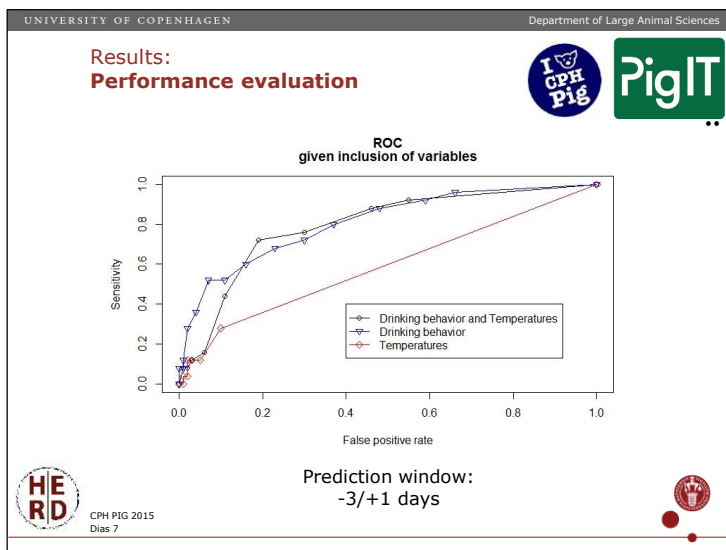
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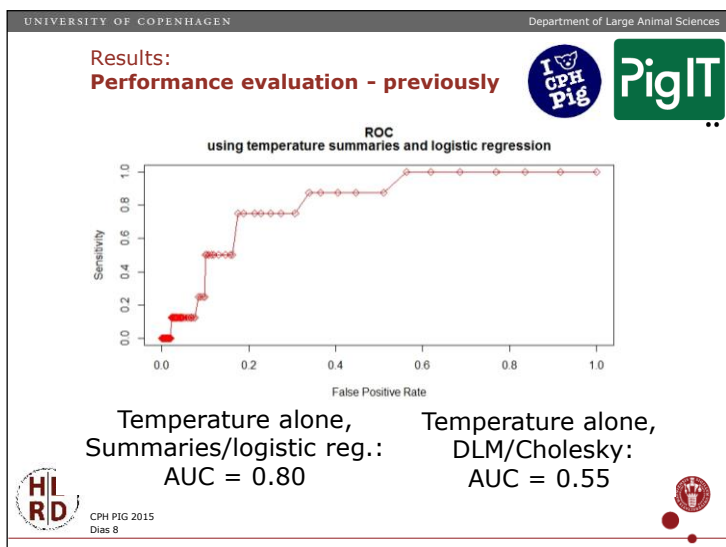
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**In Conclusion**

I CPH Pig PigIT

**Take Home Messages**

1. **Automatic detection** and early warnings can help the farmers **focus their attention** on high risk pens
2. **Drinking behavior** and **Temperature** hold the most useful information for predicting diarrhea and pen fouling
3. **Different data** types might be best exploited in **different ways** (e.g. summaries vs. modeling)

**Acknowledgements:**  
Council for Strategic Research  
Pig Research Center (VSP)  
The technical staff at Aarhus University

HERD CPH PIG 2015 Dias 9

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## Osteomyelitis in Danish slaughter pigs

By Louise Kruse Jensen, Assistant Professor, Department of Veterinary  
Disease Biology, University of Copenhagen

## Osteomyelitis in Danish slaughter pigs

Louise Kruse Jensen, DVM, PhD  
Assistant professor in Veterinary Pathology  
[Louise-k@sund.ku.dk](mailto:Louise-k@sund.ku.dk)

Osteomyelitis is a common finding in Danish slaughter pigs.

- Welfare problem for the individual pig.
- Economic problem



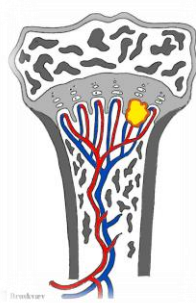
Inflammation of the bone and bone marrow = osteomyelitis

## Pathogenesis

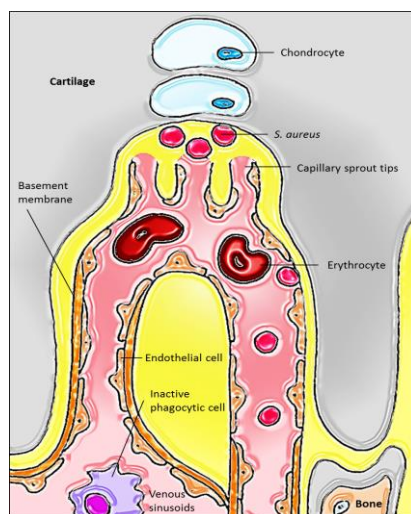
- **Systemic haematogenous**
  - Metaphysis – long bones
    - Vertebrae
    - Ribs
- **Local lymphatic/haematogenous**
  - Vertebrae, caudally from *os sacrum*
    - Tail biting
- **Traumatic**
  - Shoulder ulcerations



Concomitant tail biting and vertebral osteomyelitis in and caudally from *os sacrum* = local rejection of the pelvic bloc



Department of Veterinary  
Disease History



## Sequelae of osteomyelitis

- Pathological fracture
- Arthritis
- Soft tissue/muscular abscess
- Sequestra formation
- Retained grow
- Malformations of the bone




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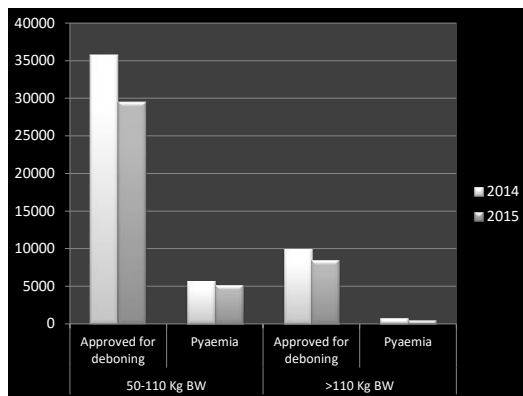
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## Incidence of osteomyelitis




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## Why is these data a problem?

- Economic




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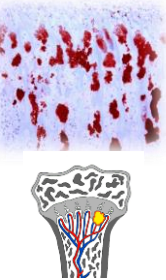
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## My research

PhD title: "Development, characterization and application of a porcine model for haematogenous osteomyelitis in children"




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## The fingerprint of osteomyelitis

"A model is a lie that helps you see the truth"

Analysis of bone tissue and blood samples for specific biomarkers of osteomyelitis (Immunohistochemistry, microRNA, mRNA)




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Benefit of my research  
for the Danish pig industry

**Finding of biomarkers for  
osteomyelitis can result in a futher  
diagnostic tool**

**Increased focus on individual welfare**

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## Monitoring growth in finishers by weighing selected groups of pigs


By Anna Helena Stygar, Post doc., Department of Large Animal Sciences,  
University of Copenhagen

UNIVERSITY OF COPENHAGEN
Department of Large Animal Sciences

Faculty of Health and Medical Sciences

Monitoring growth in finishers  
by weighing selected groups of pigs

Anna Helena Stygar  
Department of Large Animal Sciences  
University of Copenhagen  
as@sund.ku.dk



CPH Pig 03-02-2016

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Department of Large Animal Sciences

Data on body weight



- Knowledge about the herd (previous growth records)
- Insertion body weight (at batch, pen and animal level)
- Monitoring selected group of pigs (at pen and animal level)

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Slide 2

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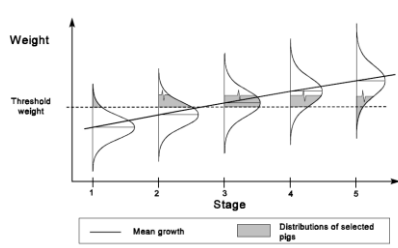
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Why to monitor body weight?



Production control

Delivery strategy

From Kure, 1997

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Slide 3

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## Objectives of this study



- Develop a monitoring and decision support tool
  - Production control
  - Marketing decisions (forecasting number of pigs above a body weight threshold)
- Quantify the value of information in finishers (including or excluding the information on body weight)

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Slide 4



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## Material and methods – data from the herd



- Batches: **9**
  - Data collected between: **2012-2015**
  - BW observations at insertion and first delivery (all pigs)
  - BW observations of selected group (every week of 2 double pens)
  - Total number of observations: **9,800**
  - Number of observations used for setting model parameters: **7,918**
  - Number of observations used for testing: **1,882**
  - Number of observed pens in a batch: **14**
  - Number of pigs inserted: **~480**
- 



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Slide 5



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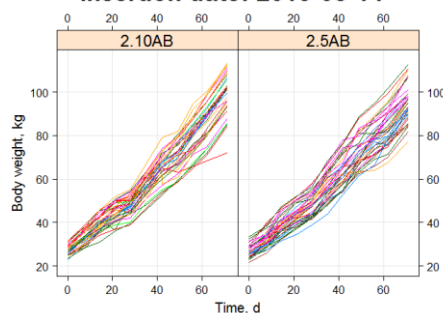
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## Material and methods – data from the herd



**Insertion date: 2013-08-14**



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Slide 6



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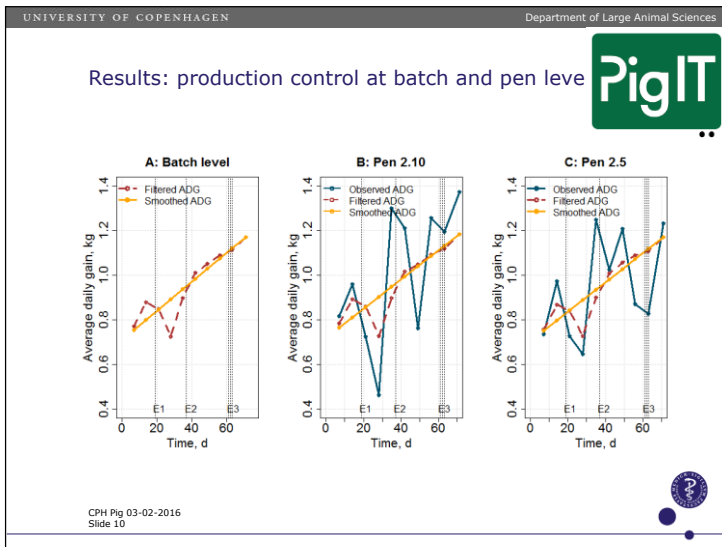
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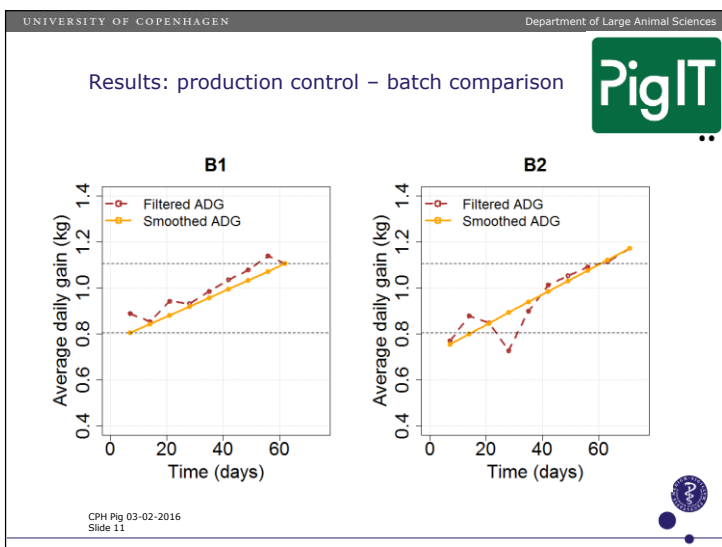
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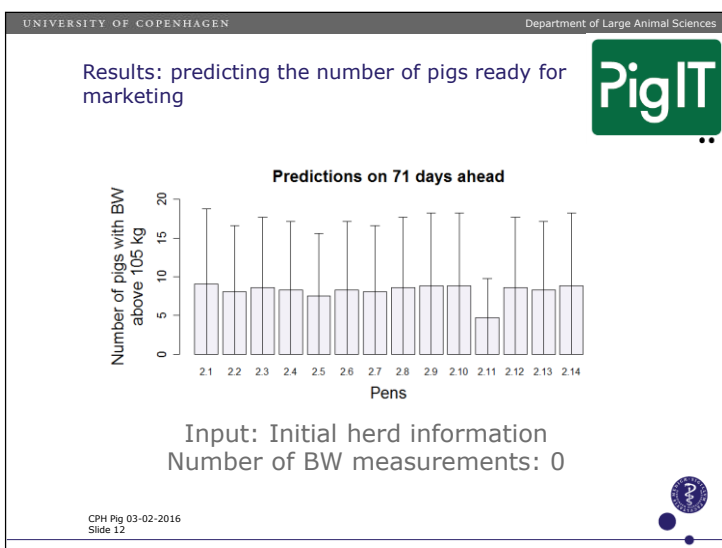
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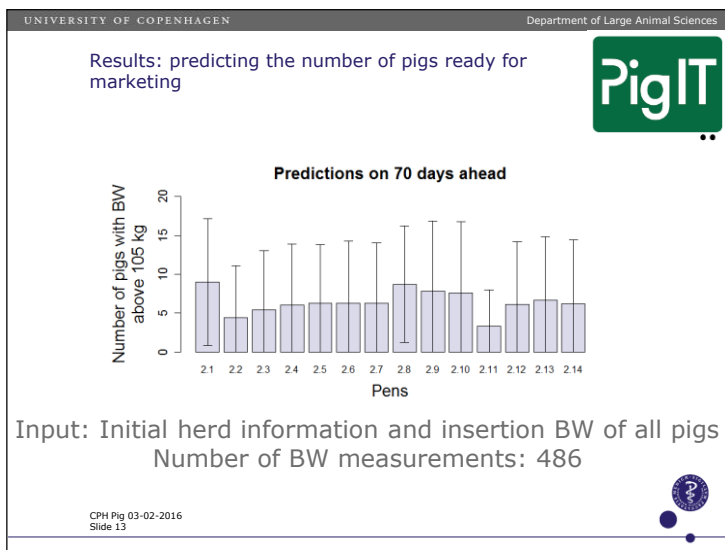
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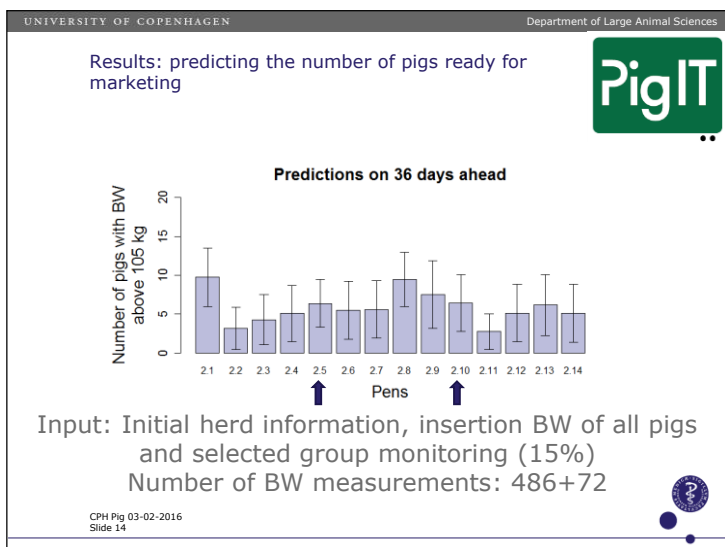
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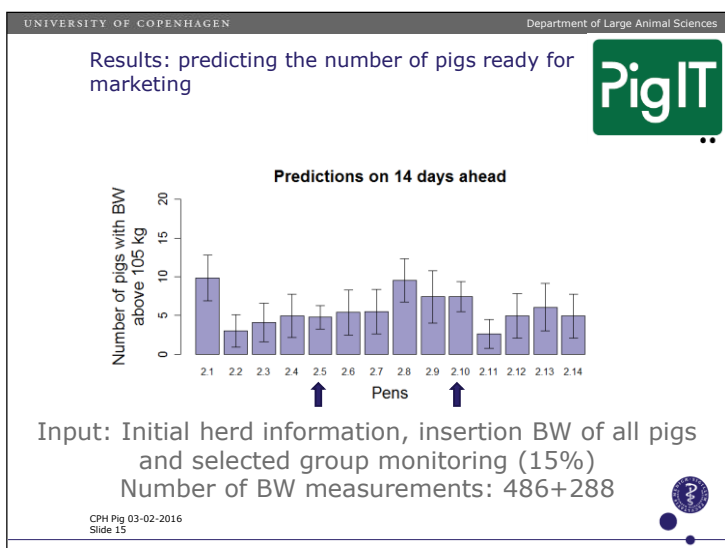
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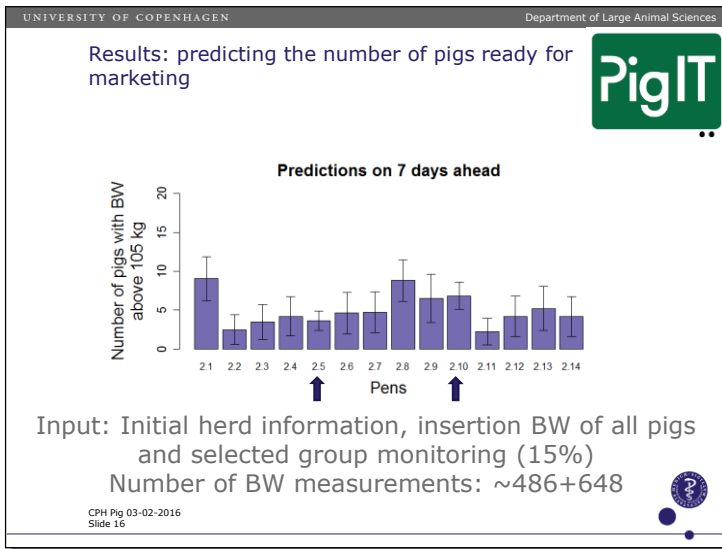
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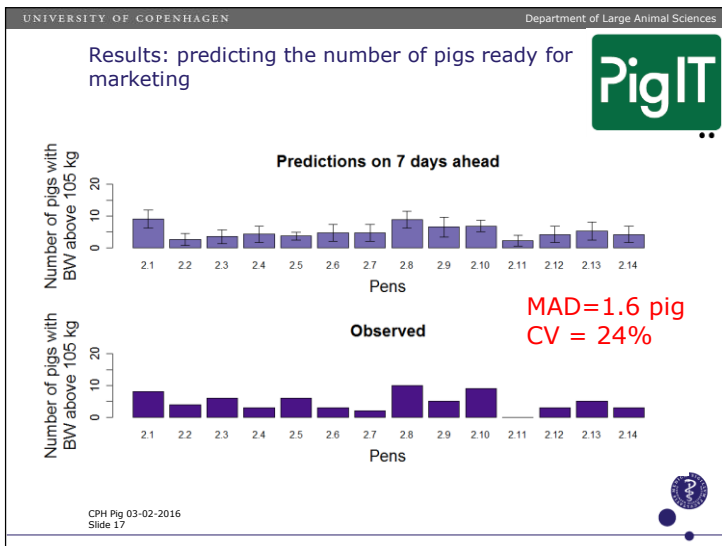
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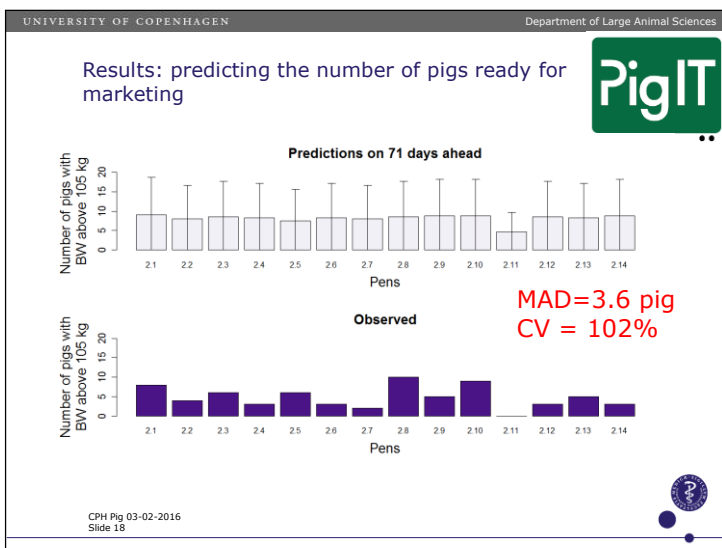
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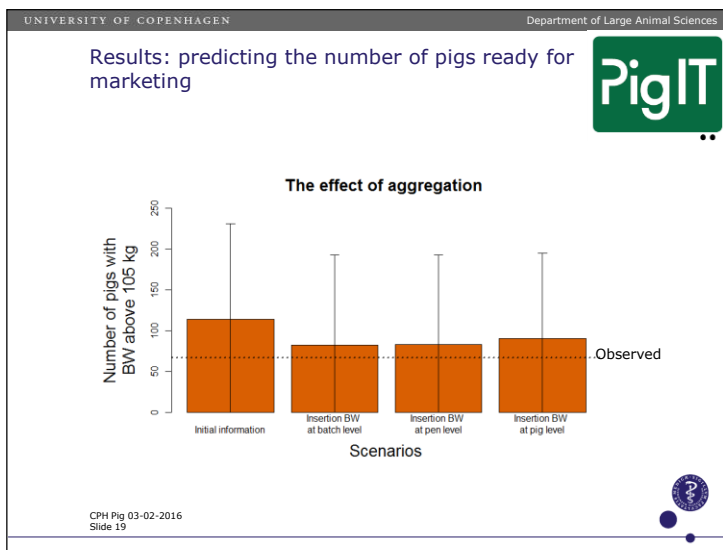
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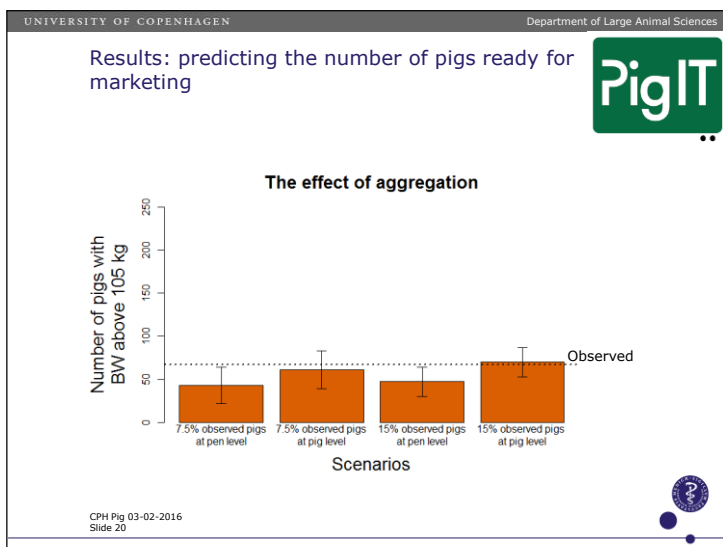
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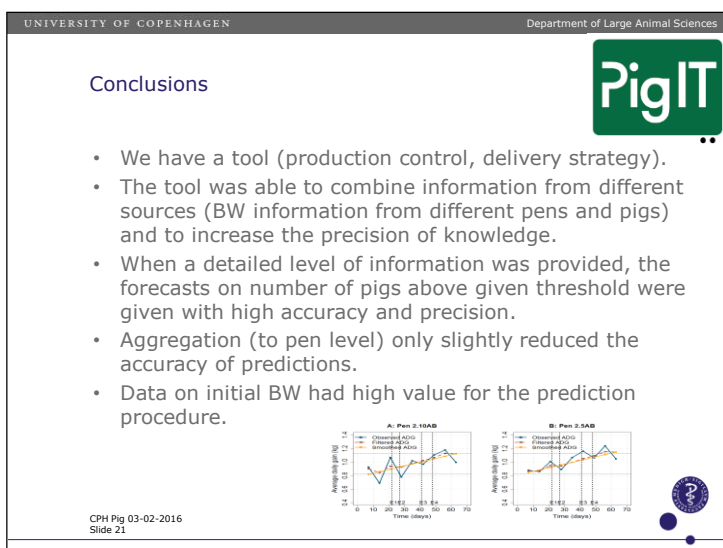
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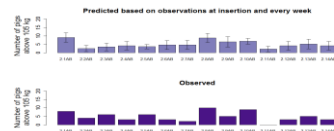
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## Conclusions – practical application



- Model can be used for production control.
- Model can be used to inform a farmer about the starting week of the delivery as well as number of pigs ready to market from a given pen.
- Further economic evaluation is necessary !!



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Slide 22



## Acknowledgments:



The Danish Council for Strategic Research



This research was supported by the Danish Council for Strategic Research (The PigIT project, Grant number 11-116191)

Project manager: Professor Anders Ringgaard Kristensen

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Slide 23







## Session 2: Sows and Piglets



## Monitoring PRRS using laboratory data

By Ana Carolina Antunes, PhD student, DTU National Veterinary Institute

## Monitoring PRRS using laboratory data

Ana Carolina Antunes\*, Fernanda Dorea, Dan Jensen,  
Tariq Halasa and Nils Toft

\*email: aclan@vet.dtu.dk

DTU Vet  
National Veterinary Institute

$$P_{se} = \frac{AP+Sp-1}{Se+Sp-1} \int_a^b \epsilon^{\Theta} + \Omega \int \delta e^{in} = (2.7182818284)$$

## What is Porcine Reproductive and Respiratory Syndrome (PRRS)?

Some general information...

- Caused by a virus
- Clinical symptoms: it varies a lot!
- Endemic in Denmark
- Serology tests performed on regular basis (SPF system)

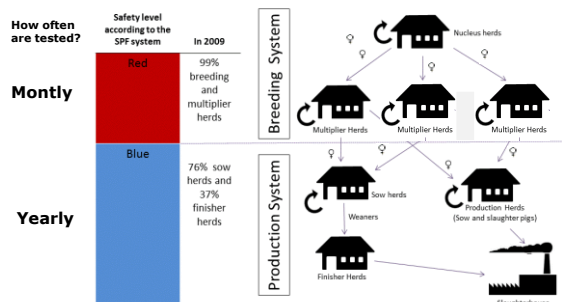


2 DTU Vet, Technical University of Denmark

03/02/2016

## Just a quick overview of the data

### Danish pig production



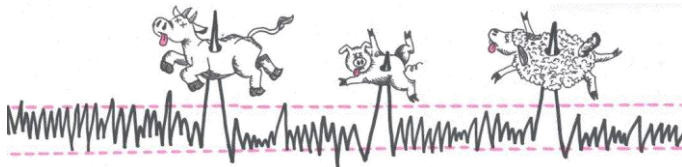
3 DTU Vet, Technical University of Denmark

03/02/2016

## What are the objective?

Monitor PRRSV in Danish swine herds

- PRRS seroprevalence
- Univariate process control algorithms
- Dynamic generalized linear models



Arinna Cosmin

## How can this be used?

- Set up a monitoring system
- Disease outbreaks detection
- Evaluate control and eradication programs
- Extended to other diseases and animals species
- Extended to other databases
- Combined with coordinates (spatiotemporal analysis)

Thank you for your attention





## Impact of feeding regime on growth in prepubertal gilts

By Sophie Van Vliet, PhD student, Aarhus University

# IMPACT OF FEEDING REGIME ON GROWTH IN PREPUBERTAL GILTS

Sophie van Vliet<sup>1</sup>, Thomas S. Bruun<sup>2</sup>, Janni Hales Pedersen<sup>3</sup>, Christian Fink Hansen<sup>3</sup>, Peter K. Theil<sup>1</sup>

<sup>1</sup> Aarhus University

<sup>2</sup> SEGES Pig Research Centre

<sup>3</sup> University of Copenhagen

[Sophie.vanvliet@au.dk](mailto:Sophie.vanvliet@au.dk)

A U AARHUS UNIVERSITY

## BACKGROUND

Currently most gilts are not fed according to their requirements

Overall aim:

Reduce feed consumption in gilts/ sows without negatively affecting production and longevity, by increasing body fat retention and reducing body protein retention in growing gilts prior to mating

Objectives:

- Manipulate growth and body composition in gilts
- (Long term consequences of altered body composition - colostrum and milk yield)

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2

## EXPERIMENT

- 3 treatments
- 48 gilts
  - 3 littermates from 16 litters
  - 60 kg LW (~15 weeks old)
- Fed according to bodyweight
- Measurements
  - Weight and backfat every second week
  - Blood samples in week 0, 4, 8 and 12
  - D<sub>2</sub>O enrichment in week 0 (n=9) and at first heat after 25 weeks of age (all)

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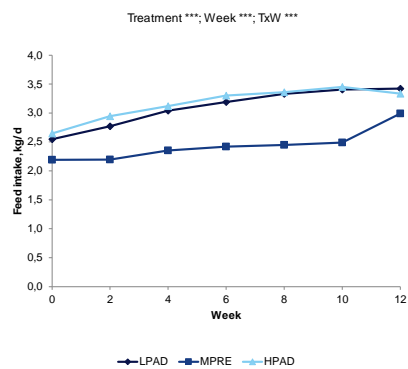
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## TREATMENTS

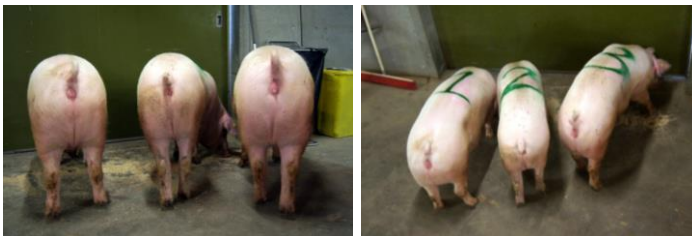
- LPAD –low protein ad libitum (4.1/ 3.3 g SID Lys/ FU ~ diet for pregnant sows)
  - High fat deposition –intermediate protein deposition
- MPRE –moderate protein restricted (5.0/ 4.1 g SID Lys/ FU)
  - Low fat deposition –low protein deposition
- HPAD –high protein ad libitum (6.6/ 5.0 g SID Lys/ FU ~ diet for slaughter pigs)
  - Intermediate fat deposition –high protein deposition

## FEED INTAKE

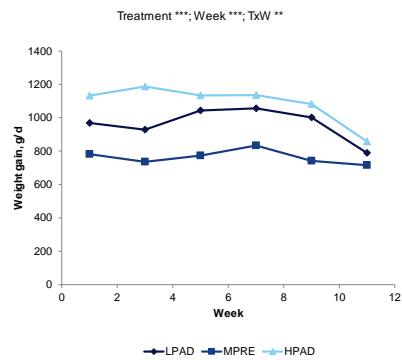


## THREE LITTERMATES

Week 12



## WEIGHT GAIN




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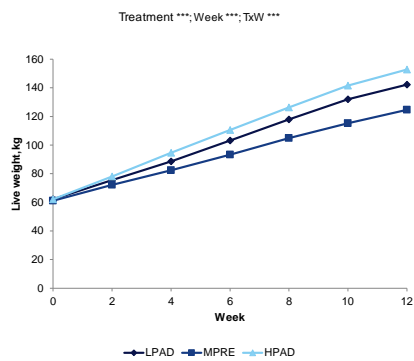
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## LIVEWEIGHT




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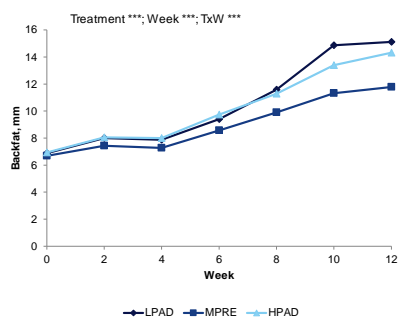
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## BACKFAT




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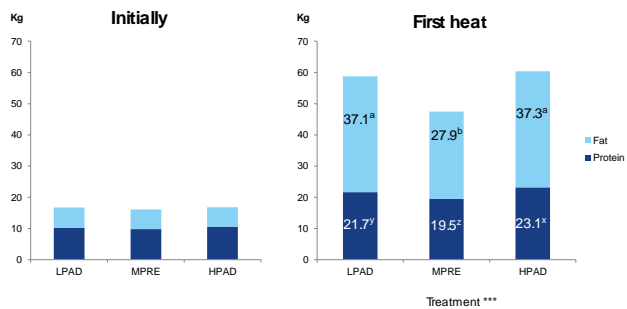
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## BODY FAT AND PROTEIN POOLS



## PLASMA METABOLITES

	Treatment			P-value
	LPAD	MPRE	HPAD	
Glucose, mM	5.57	5.46	5.57	0.30
Lactate, mM	3.01 <sup>a</sup>	3.02 <sup>a</sup>	2.34 <sup>b</sup>	0.03
Urea, mM	3.91 <sup>a</sup>	3.40 <sup>b</sup>	3.50 <sup>b</sup>	<.001
NEFA, µM	27.7 <sup>b</sup>	28.0 <sup>b</sup>	34.1 <sup>a</sup>	0.004
Triglycerides, mM	0.31 <sup>b</sup>	0.33 <sup>b</sup>	0.37 <sup>a</sup>	<.001
Insulin, pM	26.0 <sup>a</sup>	17.8 <sup>b</sup>	31.2 <sup>a</sup>	<.001
IGF-1, ng/mL	147 <sup>b</sup>	144 <sup>b</sup>	168 <sup>a</sup>	0.002

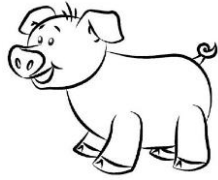
## CONCLUSION

Body fat and protein retention can be altered by feeding regime

- LPAD –high fat retention and intermediate protein retention
- MPRE –low fat and protein retention
- HPAD –high protein retention and intermediate fat retention

Follow up study -> the effects of altered body composition on colostrum and milk yield

**THANK YOU FOR YOUR ATTENTION**



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## Increasing the dietary level of protein for lactating sows affects litter gain and sow weight loss

By Thomas Sønderby Bruun, Senior Specialist, SEGES Pig Research  
Centre

UNIVERSITY OF COPENHAGEN

Faculty of Health and Medical Sciences

**EVONIK**

**I CPH Pig** **HERD**

## Increasing the dietary level of protein for lactating sows affects litter gain and sow weight loss

Thomas Sønderby Bruun, SEGES Pig Research Centre  
&  
Anja V. Strathe, Department of Large Animal Sciences

**Pig Research Centre**

Den Europæiske Landbrugsfond for udvikling af landdistrikterne  
Denmark og Europa-Unionen / Landdistrikterne

Ministeriet for Fødevarer, Landbrug og Fiskeri

LEADER 2014-2020

Den Europæiske Landbrugsfond for udvikling af landdistrikterne

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### Background

Sows are genetically different today

- Heavier when fully grown
- Larger litter size
- Less body fat content

Increased number of weaned piglets per weaning

- Possibly increased milk yield
- Reduce sow feed cost

Studies of protein requirement for lactating sows are needed

**Aim**  
Finding optimal protein concentration in feed for lactating sows

- Maximize daily gain of the litter
- Moderate weight loss for the sow

**Pig Research Centre**

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### Materials and methods – Feed composition

Treatment	1	2	3	4	5	6
Energy	1.06	1.06	1.06	1.06	1.06	1.06
FUSow per kg	1.06	1.06	1.06	1.06	1.06	1.06
SID lysine g per FUSow	5.5 5.6	6.1 6.2	6.6 6.7	7.1 7.1	7.8 7.8	8.5 8.5
SID crude protein g per FUSow	92 99↑	101 108↑	108 115↑	116 122↑	126 133↑	136 143↑

Black = planned  
Pink = realized

**Pig Research Centre**

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## Materials and methods – 540 sow study

## Placement

- Sow body weight
- Sow backfat



## Day 2

- Litter equalisation  
14 piglets/sow
- Litter weight
- Sow body weight
- Sow backfat



## Weaning

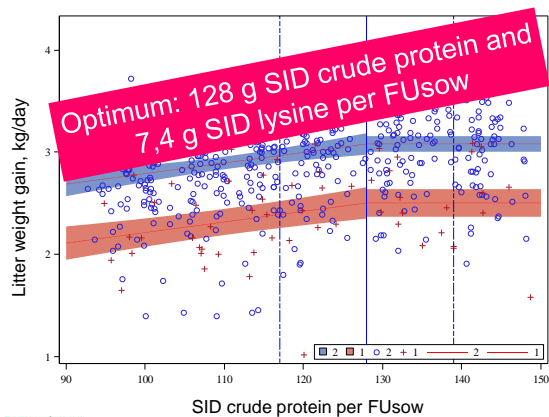
- Litter weight
- Sow body weight
- Sow backfat



Pig Research Centre



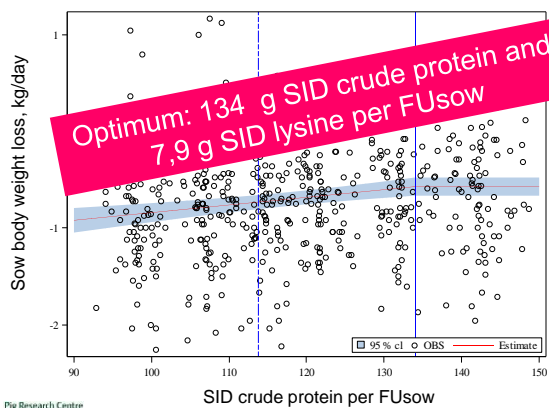
## Results – Average daily litter gain



Pig Research Centre



## Results – Sow weight loss



Pig Research Centre



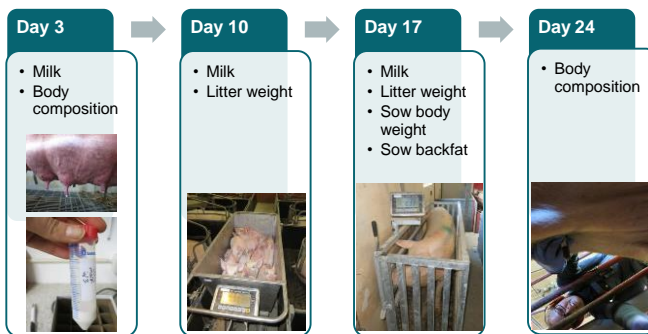
## Results

### Subsequent reproduction

- No effect on the number of days to first mating
- No effect on farrowing rate
- Marginal effect on litter size

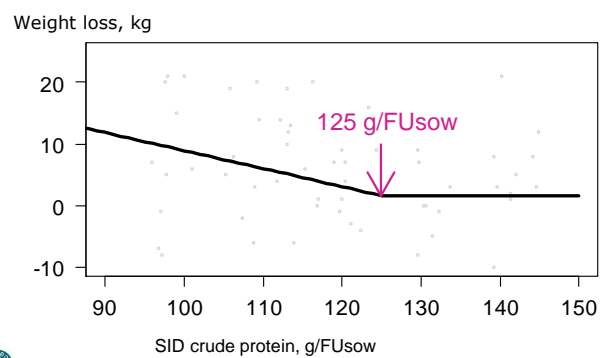


## Materials and methods – 72 sow study



## Results

- Less weight loss in last week of lactation

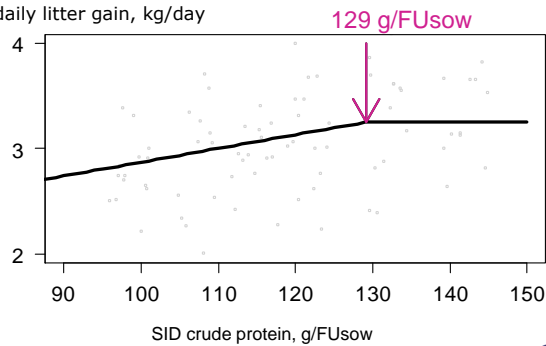




## Results

- Litter weight gain week 3

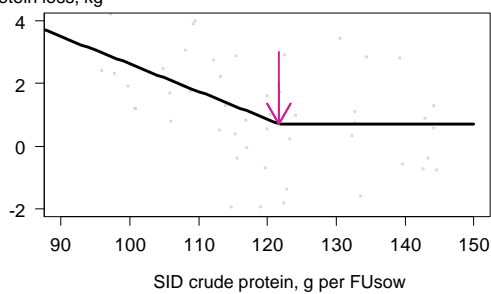
Average daily litter gain, kg/day



## Results

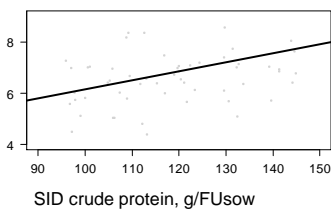
Increase in protein → decrease in mobilization

Body protein loss, kg

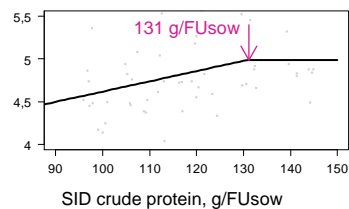


## Results – Sow milk composition

Milk fat, %



Milk protein, %



## Conclusion

### Increase protein during lactation

- Increased litter weight gain
- Reduced sow body weight loss
  - Limited mobilization of muscle protein
  - Increased mobilization of fat
- Increased nutritional content in milk
- (No influence on prevalence of piglet diarrhea)

### Subsequent reproduction was not affected

- Minor positive effects of increased protein on subsequent litter size

**Thank you for your attention!**



Gastric emptying rate and blood values in newborn intra-uterine growth  
restricted piglets

By Charlotte Amdi Williams, Post doc., Department of Large Animal  
Sciences, University of Copenhagen

KOBENHAVNS UNIVERSITET Department of Large Animal Sciences

Det Sundhedsvidenskabelige Fakultet

## Gastric emptying rate and blood values in newborn intra-uterine growth restricted piglets

**Charlotte Amdi Williams** Ph.d., Post doc, [ca@sund.ku.dk](mailto:ca@sund.ku.dk)  
University of Copenhagen, Department of Large Animal Sciences




CPH Pig 03/02/16  
Dias 1

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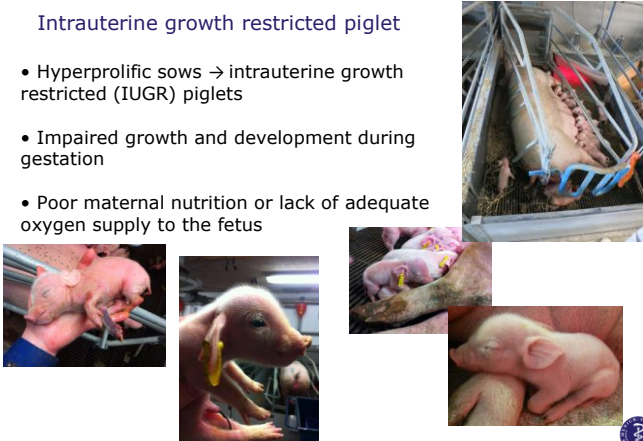
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## Intrauterine growth restricted piglet

- Hyperprolific sows → intrauterine growth restricted (IUGR) piglets
- Impaired growth and development during gestation
- Poor maternal nutrition or lack of adequate oxygen supply to the fetus



CPH Pig 03/02/16  
Dias 2

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## Intrauterine growth restricted piglet

- More nutrients are redirected to brain and heart → fetal adaptive reaction (Roza *et al.*, 2008)
- 25 % to 30 % of newborn piglets in DK suffer from IUGR when defined on their headshape (Hales *et al.*, 2013, Amdi *et al.*, 2013)
- Higher mortality rate in IUGR piglets (Hales *et al.*, 2013)



CPH Pig 03/02/16  
Dias 3

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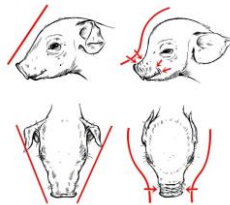
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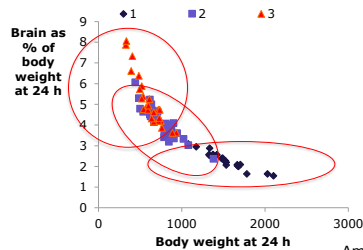
### Intrauterine growth restricted piglet

#### Characteristics:

- Steep dolphin-like forehead
- Bulging eyes
- Hair with no direction of growth



Hales *et al.*, (2013), JAS



Amdi *et al.*, (2013), JAS

CPH Pig 03/02/16  
Dias 4



### The IUGR piglet's problem?

- They can not digest the amount of recommended colostrum (Amdi *et al.*, 2013)
- Up to 50 % of piglets that die within the first few days have empty stomachs (Hales *et al.*, 2013)



Therefore we investigated:

How quickly do the stomachs empty?

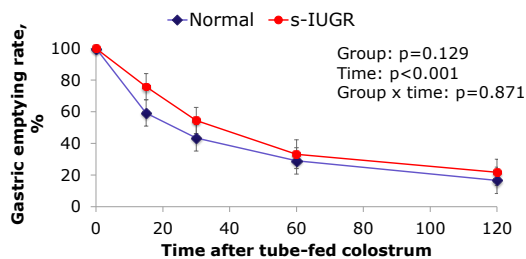
- 48 piglets – 24 IUGR, 24 Normal
- Tube-fed 12 mL/kg porcine colostrum at birth
- Euthanised after 15, 30, 60 and 120 min



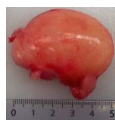
CPH Pig 03/02/16  
Dias 5



### Gastric emptying rate

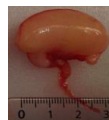


Preliminary results: Amdi, Klarlund *et al.*,  
in manuscript preparation



5 cm

Normal



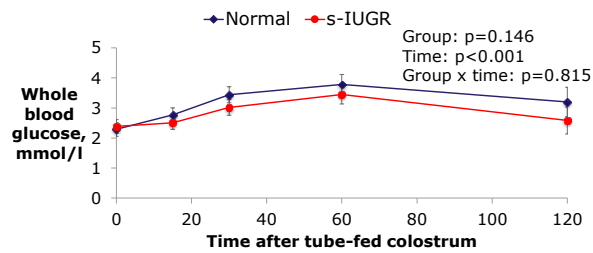
IUGR

3 cm

CPH Pig 03/02/16  
Dias 6



## Blood values

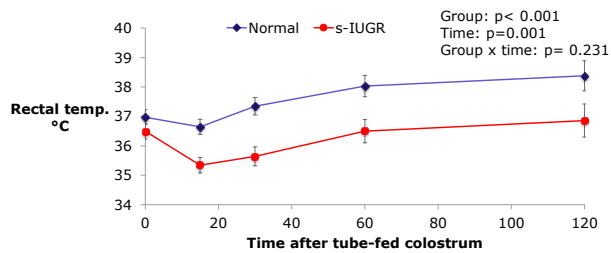


No difference between groups  
Difference over time

Preliminary results: Amdi, Klarlund et al., in manuscript preparation

CPH Pig 03/02/16  
Dias 7

## Rectal temperatures (influences survival)



- Differences between groups and over time
- Drop in temp during the first 15 min.
- Difference of 1.3 °C in rectal temperatures

Preliminary results: Amdi, Klarlund et al., in manuscript preparation

CPH Pig 03/02/16  
Dias 8

## The IUGR piglet's problem?

How often can we give IUGR piglets colostrum?

## 4 groups of IUGR piglets:

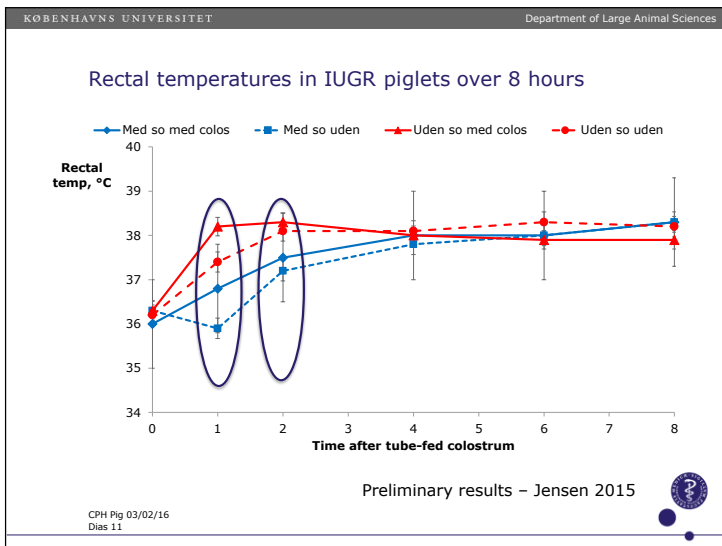
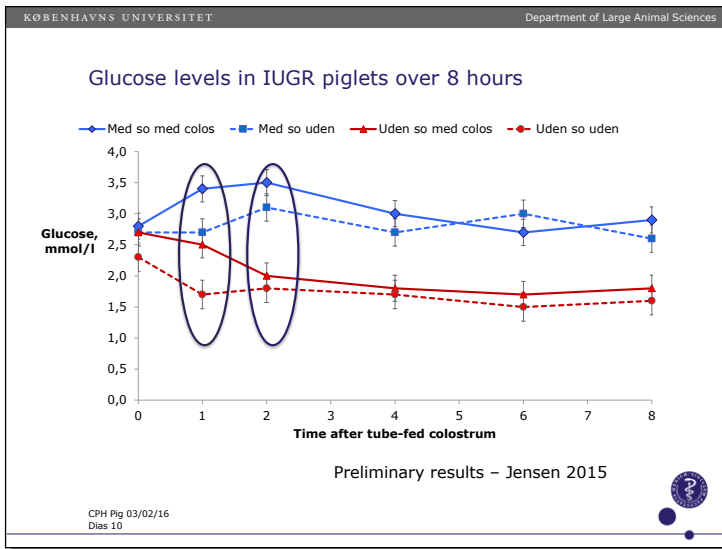
- With sow with colostrum
- With sow without colostrum
- Without sow with colostrum
- Without sow without colostrum



How much of an effect does the sow have?  
Additional heat?  
Additional colostrum?

Tube-fed 12 mL/kg colostrum at birth  
Weighed  
Rectal temp

CPH Pig 03/02/16  
Dias 9



KØBENHAVNS UNIVERSITET Department of Large Animal Sciences

### Take home message

- Gastric emptying rate is similar
- Stomachs are small and empty fast
- IUGR piglets might be more challenged in blood glucose
- Colostrum increases rectal temperatures with one degree
- However colostrum has to be given every hour...
- The sow has an effect

IUGR piglets after 2 weeks

CPH Pig 03/02/16  
Dias 12

**Thank you:**

Pig Levy Fund (Svineavgiftsfonden) for support and funding



The group at KU: Prof Christian Fink Hansen, Post doc Janni Hales, Phd stud Anja Strathe, speciale stud Mette Versner Klarlund, Laura Lundgaard Jensen and Camilla Højgaard



Thank you to Askelygaard for their IUGR piglets and help ☺

And a thank you to Julie Lynegaard and Maiken Engelsmann for letting us use some of their pictures ☺

CPH Pig 03/02/16  
Dias 13



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## Session 3: Welfare



## The use of virtual herds in veterinary and agricultural education

By Karl Johan Møller Klit, PhD student, Department of Large Animal Sciences, University of Copenhagen



## The use of virtual herds in veterinary and agricultural education

Karl Johan Møller Klit DVM, PhD-Student, Camilla Kirketerp Nielsen DVM, PhD-Student  
[karl.johan.klit@sund.ku.dk](mailto:karl.johan.klit@sund.ku.dk), [cape@sund.ku.dk](mailto:cape@sund.ku.dk)  
 Department of Large Animal Sciences



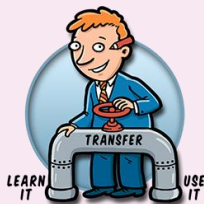
## Why virtual herd?

- Teaching environment



## Transfer

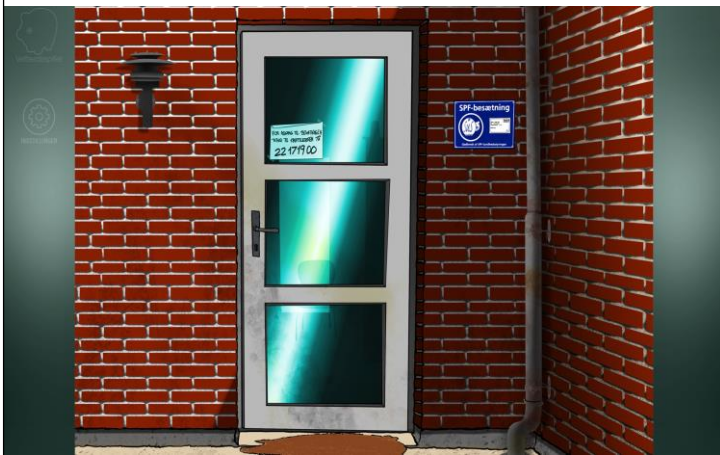
- The ability to use a skill beyond the present context
- To be value – any skill must be transferable to real life

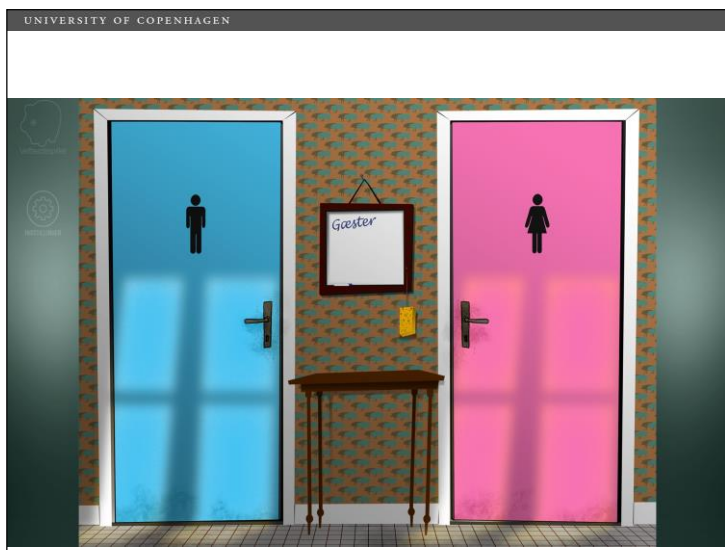


## Farrowing unit

### Aim/Purpose

- Increase Animal Welfare
- Piglet survival
  - Farrowing assistance
  - Farrowing fever
  - Piglet environment





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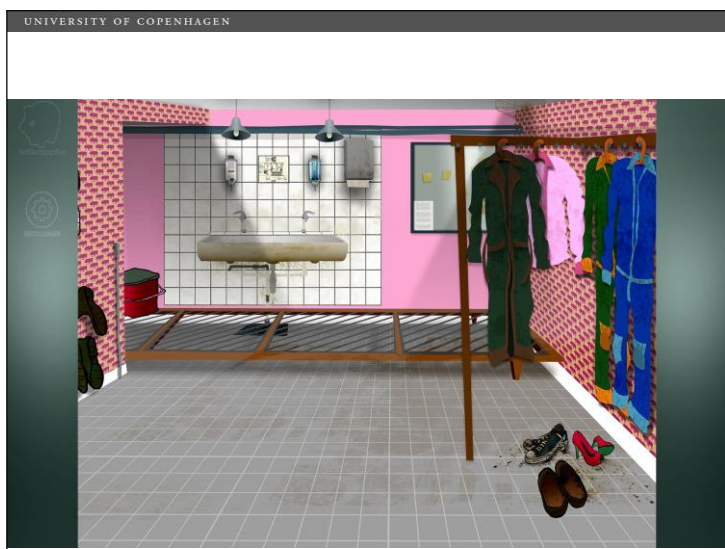
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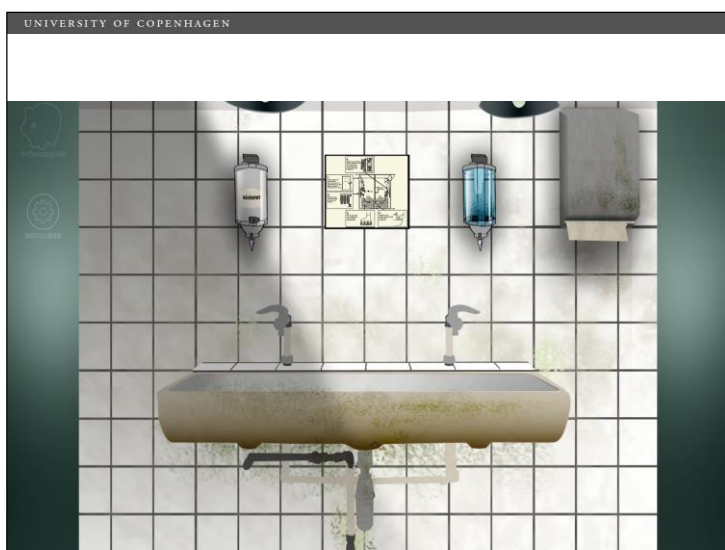
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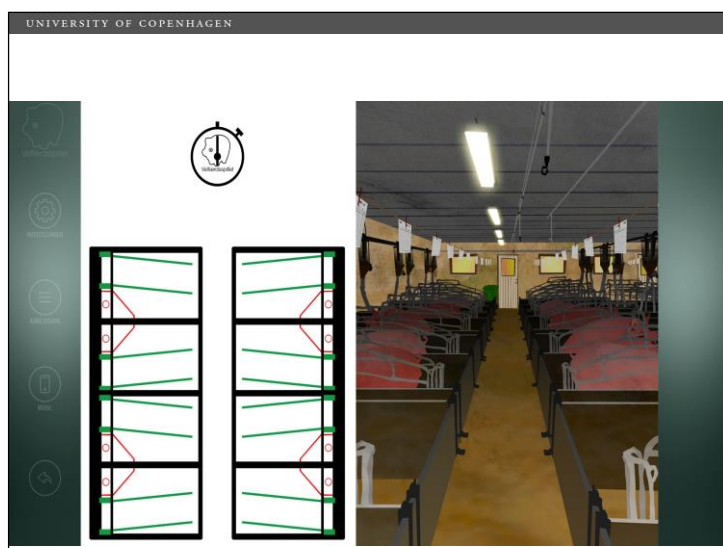
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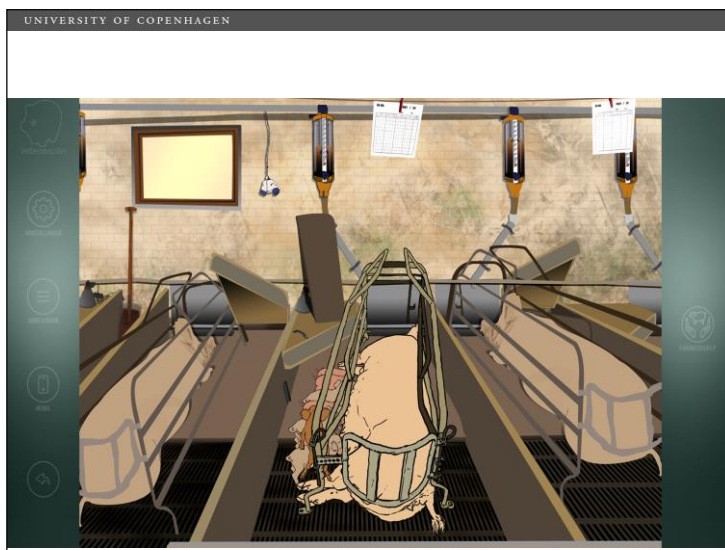
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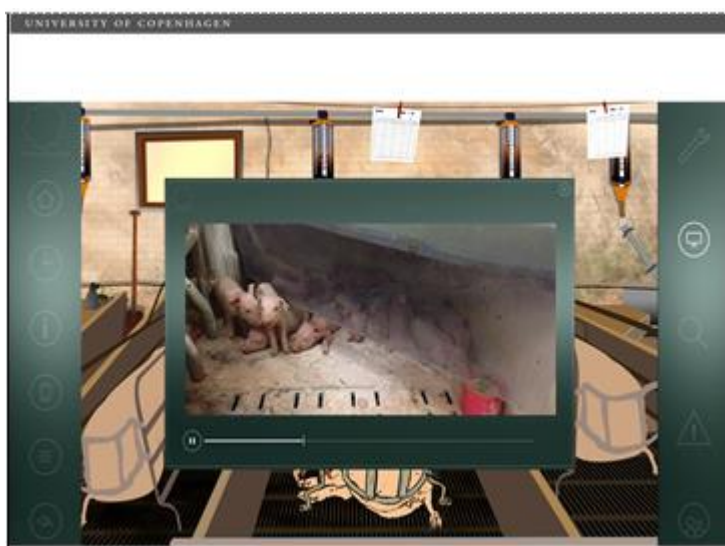
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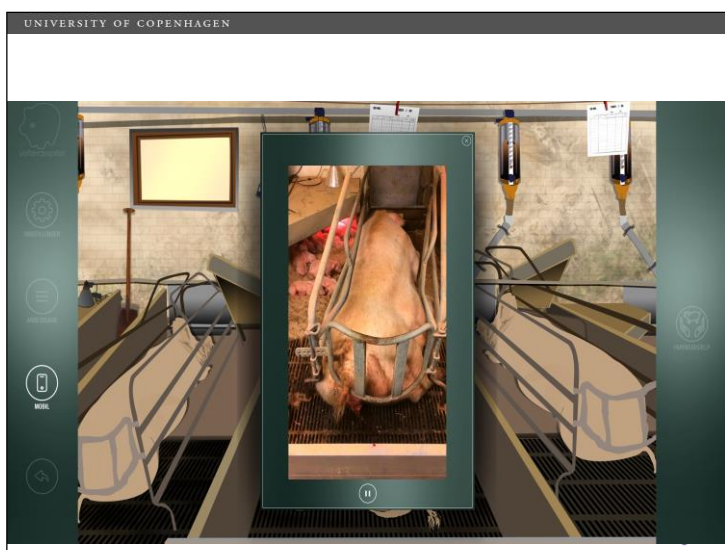
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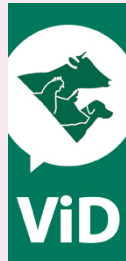
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Thank you

**Svineafgiftsfonden**



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## Assessing farms with the Danish animal welfare index

By Marlene Kirchner, Assistant professor, Department of Large Animal Sciences, University of Copenhagen

KØBENHAVNS UNIVERSITET Institut For Produktionsdyr og Heste - Dyrevelfærd og Sygdomsbekæmpelse

Det Sundhedsvidenskabelige Fakultet

## Assessing farms with the Danish animal welfare index

Marlene Kirchner  
Department of Large Animal Sciences  
[mk@sund.ku.dk](mailto:mk@sund.ku.dk)



Copenhagen Pig 2016 Marlene K. Kirchner Section for Animal Welfare and Disease Control  
Dias 1

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## What is an animal welfare index?

An animal welfare assessment evaluates the welfare state of the animals at that specific point in time, representative for a period

The DAW- Index makes it possible to study the development of animal welfare over time, eg. several years.

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Dias 2

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## The project

Project runs 2013-2016

- Farrowing sows & piglets, gilts and gestating sows, fattening pigs
- Index 1.
  - Based on existing registrations (meat control, use of antibiotics)
- Index 2.
  - Based on farm visits, preferred animal based measures
- Index 3.
  - Best combination of 1 & 2

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Dias 3

© B.Forkman

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### The 'survival factors' for included indicators


- Hedonistic definition of animal welfare
- Validity – reliability – feasibility
- Experts round
- On-farm visits [90 Pig herds]
- Welfare Quality comparison
- Recording time max. 1hour

DUNCAN, 1996; KNIERIM & WINCKLER, 2009; WHAY ET AL., 2004; WELFARE QUALITY, 2009

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Dias 4

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Section for Animal Welfare and Disease Control



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### Which aspects of Animal Welfare are covered by DAWIN?

4 Principles of Animal Welfare	Indicators
Good Feeding	Behavioural
Good Housing	Clinical
Good Health	Resources
Appropriate Behaviour	Records

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Dias 5

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### The 'surviving' indicators included in DAWIN


27 for farrowing sows  
22 for weaner and fattener  
21 for piglets  
28 gestating sows and gilts

Can change until the final version!

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Dias 6

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KØBENHAVNS UNIVERSITET		
Institut For Produktionsdyr og Heste - Dyrevelfærd og Sygdomsbekæmpelse		
Farrowing sows – part 1		
Principles (WQ)	Indicators	Type
Good Feeding	Body condition score (0/1)	Animal-based
	Roughage (No/Access to roughage)	Resource-based
	Feeding system (Non/competitive)	Resource-based
	Water supply (clean/sufficient)	Resource-based
Good Housing	Farrowing system	Resource-based
	Farrowing rails	Resource-based
	Space in farrowing system	Resource-based
	Resting area	Resource-based
	Ammonia	Resource-based
	Manure on the body	Animal-based
	Bursitis	Animal-based
	Panting	Animal-based
	Nursing sows	Animal-based
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Dias 7		

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Farrowing sows – part 2		
Principles (WQ)	Indicators	Type
Good health	Hampered respiration	Animal-based
	Shoulder wounds	Animal-based
	Integument alterations	Animal-based
	Vulva lesions	Animal-based
	Prolapse	Animal-based
	Hernia	Animal-based
	Nose ring	Animal-based
	Overgrown claws	Animal-based
	Proper euthanasia	Resource-based
	Hospital pens	Resource-based
	Mortality	Resource-based
Appropriate Behaviour	Stereotypies	Animal-based
	Rooting material	Resource-based
	Possibility to perform nest building behaviour	Resource-based

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Institut For Produktionsdyr og Heste - Dyrevelfærd og Sygdomsbekæmpelse		
Weaner and fatterer – part 1		
Principles (WQ)	Indicators	Type
Good Feeding	Body condition score	Animal-based
	Feeding system	Resource-based
	Water supply	Resource-based
Good Housing	Stocking density	Animal-based
	Resting area	Resource-based
	Cooling	Resource-based
	Ammonia	Resource-based
	Slipperiness of the floor	Animal-based
	Manure on the body	Animal-based
	Panting	Animal-based
Copenhagen Pig 2016      Marlene K. Kirchner      Section for Animal Welfare and Disease Control		
Dias 9		

## Weaner and fatterer – part 2

Principles (WQ)	Indicators	Type
Good health	Lameness	Animal-based
	Integument alterations	Animal-based
	Tail bite	Animal-based
	Ear damage	Animal-based
	Rectal prolapse	Animal-based
	Hernia	Animal-based
	Twisted snout	Animal-based
	Neurological symptoms	Animal-based
	Proper euthanasia	Resource-based
	Hospital pens	Resource-based
	Mortality	Animal-based
Appropriate Behaviour	Rooting material	Resource-based

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Dias 10

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Section for Animal Welfare and Disease Control



## The future of the DAWIN project

2015

### Visiting farms

### Expert weightings of the measures

2016

### Further shaping of the indicators

### Aggregation of on farm measures

### Constructing an index

COMING SOON !!!  
DAW - Index 2016

Copenhagen Pig 2016  
Slide 11

Marlene K. Kirchner

Section for Animal Welfare and Disease Control



Many thanks go to...

Danish Veterinary and Food Administration

Louise Holm

Ministeriet for Fødevarer, Landbrug og Fiskeri  
Fødevarestyrelsen



Copenhagen University

Björn Forkman, Hans Houe,  
Anne Marie Michelsen, Nina Otten,  
Søren Saxmose Nielsen,  
Matt Denwood, Henrik Elvang



Aarhus University

Jan Tind Sørensen, Tine Rousing



Thank you for your attention!

[mk@sund.ku.dk](mailto:mk@sund.ku.dk) [www.researchgate.net/Marlene\\_Kirchner](http://www.researchgate.net/Marlene_Kirchner)

Copenhagen Pig 2016  
Slide 12

Marlene K. Kirchner

Section for Animal Welfare and Disease Control







## Tail biting: prevalence among docked and undocked pigs from weaning to slaughter

By Helle Pelant Lahrmann, Industrial PhD student, Department of Large Animal Sciences, University of Copenhagen & SEGES Pig Research Centre



**TAIL BITING: PREVALENCE AMONG DOCKED AND UNDOCKED PIGS FROM WEANING TO SLAUGHTER**

Helle Pelant Lahrmann, Industrial Ph.D. Student

**I CPH Pig**

**Dan Avl**

**SRUC**

February 3th 2016

**SEGES**  
Videncenter for Svineproduktion

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## INTRODUCTION

- EU directive bans routine tail docking
- More than 95% of European pigs are tail docked (EFSA 2007)
- Estimated 3.1% of Danish pigs tail bitten despite the tail docking procedure (D'Earth et al., 2014)
- The consequences of a cessation of tail docking in conventional Danish piggeries are not known

### Study aim

*Determine consequences of tail docking cessation on tail biting in a well-managed Danish conventional herd.*




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## DEFINITION TAIL BITING & TAIL LESION

- Tail biting is a behaviour – damaging or non-damaging
- Definition damaging tail biting
  - Pig's chew on a pen mates tail resulting in a bloody wound on the tail (Munsterhjelm et al. 2013)
- Damaging tail biting
  - is painful to the pig
  - can develop to such an extent that the pig loses the majority of the tail
  - increases the risk of infections
  - increases the need for antibiotic treatments
  - may cause death or euthanasia (Kritas & Morrison 2004 & 2007)
- Tail lesion is a condition

Tail biting



Tail lesion




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## MATERIAL & METHODS

- Two groups
  - +/- tail docking
- Housing
  - Same pen from weaning to slaughter (stable group)
  - Docked and undocked pigs in different pens
  - 20-22 pigs per pen, mixed gender
  - Daily provision of ~230 g straw on the floor until 70 kg + two vertical wooden sticks per pen
  - If tail biting occurred a Bite Rite was added and the amount of straw was doubled
- Animals
  - LYD – pigs, castrated males, individually earmarked



Bite Rite

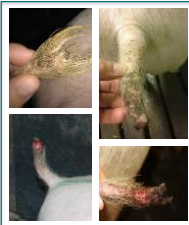
## PEN DESIGN



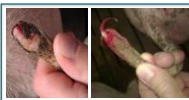
## RECORDINGS

- Every second week all tails were inspected by a trained technician
- Recordings by stockperson
  - Date tail biting outbreak
  - Antibiotic treatments
  - Dead/euthanized pigs
  - Pigs removed from pen and cause
- Abattoir
  - Tail lesion comments/condemned

Part missing



Full length



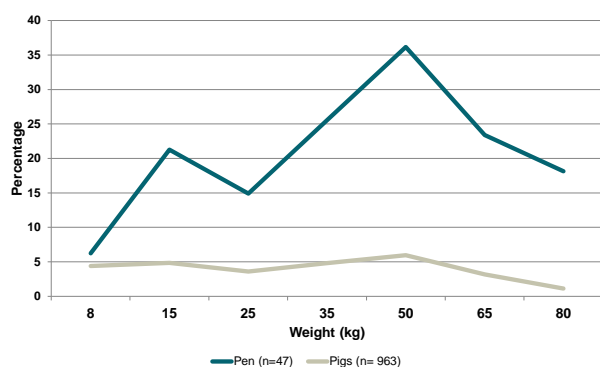
## PRELIMINARY RESULTS

	Undocked	Docked
Pigs, n	963	964
Pens, n	47	48
Tail bitten, n	214	0
Infected tail injury, n	24	-
Dead pigs, n	30 (3 TB)	37
Hospital pen, n	38 (25 TB)	12

- On average 3.6 % of the pigs per scan had a tail injury
- In 19 % of the pens per scan there were pigs with tail injuries
- On average the first tail biting incidence was observed 45 days after weaning
- Gender tail bitten pigs: 77 gilts, 123 castrated males and 14 "unknown"



## PRELIMINARY RESULTS TAIL BITING, 8-80 KG



## PRELIMINARY CONCLUSIONS

- Cessation of tail docking in a well managed herd with a high health status and low occurrence of tail biting among docked pigs:
  - Increased the risk of tail biting
    - despite low stocking density from 7-30 kg and straw
  - Increased the need for hospital pens
  - Did not increase number of dead pigs – if the tail biting could be stopped
  - Abattoir remarks underestimated the prevalence of tail bitten pigs



THANK YOU FOR YOUR ATTENTION!!!



Challenging  
task!...



Finishers with intact curly tails



## Loose housed sows with low piglet mortality

By Janni Hales Pedersen, Post doc., Department of Large Animal Sciences, University of Copenhagen


UNIVERSITY OF COPENHAGEN

Faculty of Health and Medical Sciences



**Loose housed sows with low piglet mortality**


Janni Hales Pedersen  
Post Doc  
Department of Large Animal Sciences  
[hales@sund.ku.dk](mailto:hales@sund.ku.dk)

February 2016

 Pig Research Centre

This project was founded by the Danish Centre for Animal Welfare




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**Background**

Danish industry

- 10 % loose housed lactating sows

Loose housed sows is a challenge

- Higher piglet mortality
- Temporary confinement for 4 days reduces mortality
- Not all sows have high mortality

Identify good sows

- Do they have a better farrowing process?
- Are they more active?
- Do they perform more pre-lying behaviour?



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**Experiment**

**Video recordings of 40 sows**

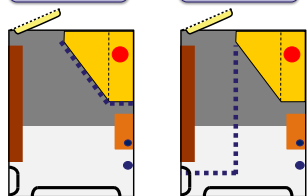
- Parity 1 and 2
- Observation from end of farrowing to litter equalization


**Registrations**

- Farrowing duration
- Postural changes
- Pre-lying behaviour
- Piglet behaviour

Good sows	Bad sows
0-1 dead piglet before equalization	2+ dead piglets before equalization

Loose      Confined



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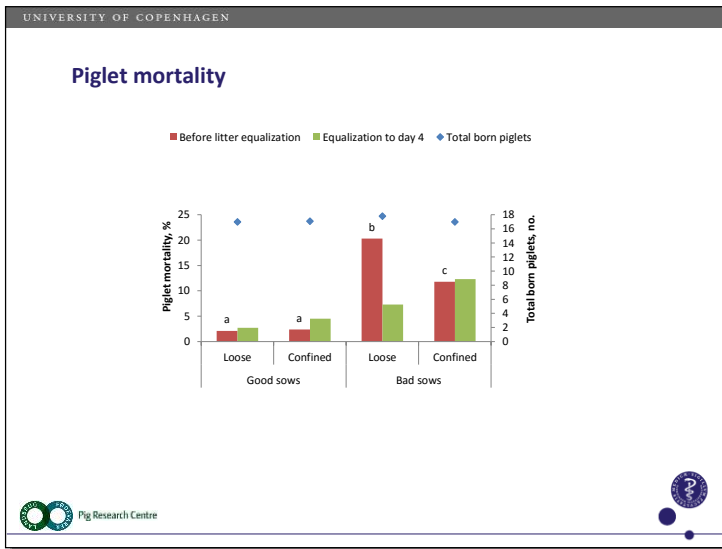
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### Duration of farrowing and observational period

	Good sows		Bad sows		P-value	
	Loose	Confined	Loose	Confined	Housing	Mortality
Sows	8	8	8	4		
Farrowing duration, min	241	204	261	273	0.69	0.20
Time to litter equalization, h	9	14	14	16	0.18	0.21

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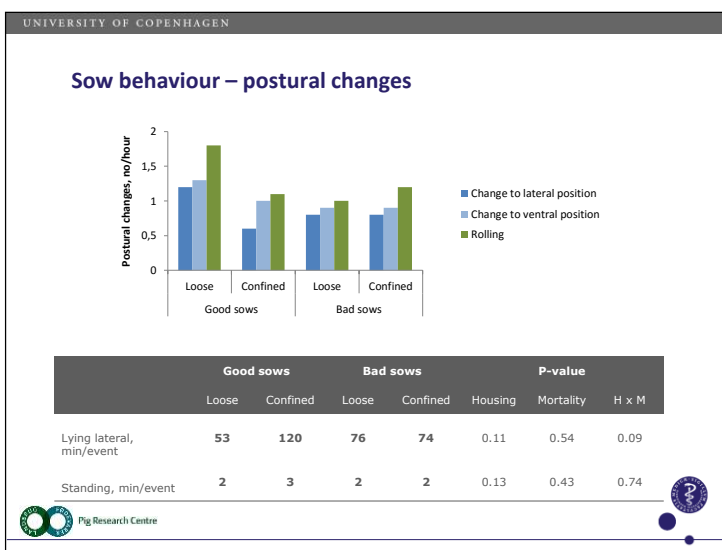
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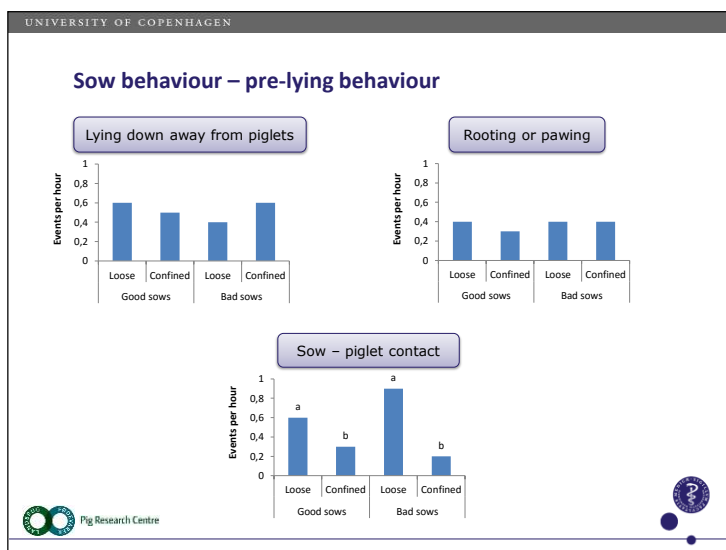
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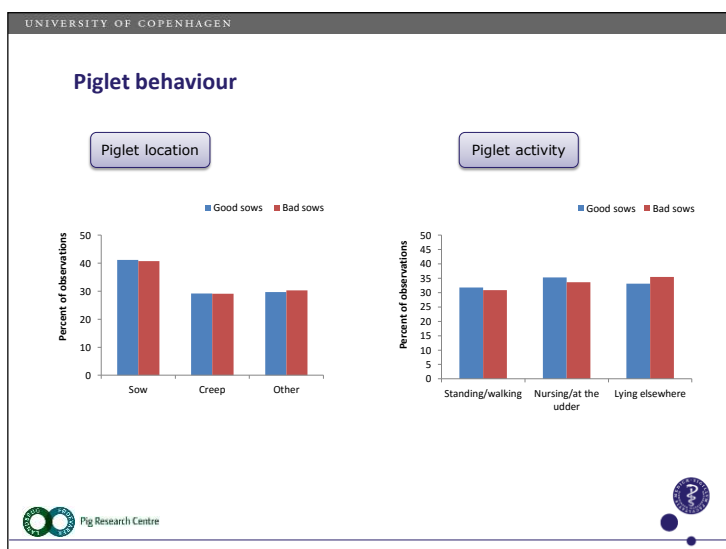
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### Conclusions

**Possible indicators of low piglet mortality**




**Sow related**

- Duration of farrowing ➕
- Activity or inactivity ➕
- Performance of pre-lying behaviours ➕

**Piglet related**

- Location in per ➕
- Activity or inactivity ➕

**Total born piglets and parity are still the best indicators of low or high piglet mortality.**

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**Thank you for your attention!!!**





## Session 4: MRSA



## Levels of MRSA on pigs and environmental samples

By Julie Elvekjær Hansen, PhD student, DTU National Veterinary Institute

DTU

## Levels of MRSA on pigs and environmental samples

**Julie Elvekjær Hansen**  
MSc. in Biology-Biotechnology, PhD student

*Technical University of Denmark, National Veterinary Institute,  
Frederiksberg, Denmark*

juhan@vet.dtu.dk



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National Veterinary Institute

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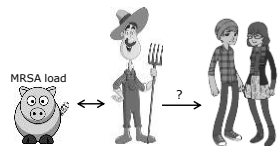
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DTU

Introduction > Aim > Method > Method verification > Results > Concluding remark

## LA-MRSA is a public health concern

- Denmark: overall MRSA level is low
- Ambition of maintaining low levels of MRSA
- Increasing prevalence in livestock, especially in pig production – LA-MRSA load not known
- LA-MRSA reservoir – possibility of spread into the general population
- Control and prevention of increasing MRSA level in community
- Assessment of intervention strategies



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DTU

Introduction > Aim > Method > Method verification > Results > Concluding remark

## Aims of the study

- To assess the possibilities of quantification of the animal MRSA load by nasal and skin swab samples
- To test two different active air samplers for quantification of airborne MRSA as a measure of environmental MRSA load

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Introduction
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Concluding remark
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### Quantification of animal load and air load

- Colony counts and determination of colony forming units →  

$$CFU/ml(\text{swab}) = \frac{\text{count} \times \text{dilution factor}}{0.1ml}$$

**Sampl'air**  
250l on blood  
Duplicates of 250l on MRSA 2

**Sartorius (MD8)**  
250l on blood  
Duplicates of 250l on MRSA 2

Sampl'air: different volumes directly onto Brilliance<sup>TM</sup> MRSA 2  
Sartorius: different volumes onto gelatine filter and incubated on Brilliance<sup>TM</sup> MRSA 2

- Determination of CFU/m<sup>3</sup>

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### Animal load - Biological and technical replicates

- Sampling : 3 pigs
- 4x3 swabs were obtained as: 3 nasal swabs + 3 skin swabs from each side of the pig
- Each of biological replicates were divided and analysed as three technical replicates in the lab, leading to 36 samples from each pig in total

Source	Nasal swabs		Skin swabs	
	Variance	%	Variance	%
Bio. replicate	0.37	24	0.08	31
Pig	1.11	72	0.13	53
Residual	0.06	4	0.04	15
Total	1.54	100	0.25	100

CFU based on counts from 10<sup>-2</sup>, where the 10<sup>-1</sup> counts were zero

**Nasal swabs seems to cause greater variation in the results than use of skin swabs. For nasal swabs a larger proportion of the variance can be explained by the difference between pigs.**

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Introduction
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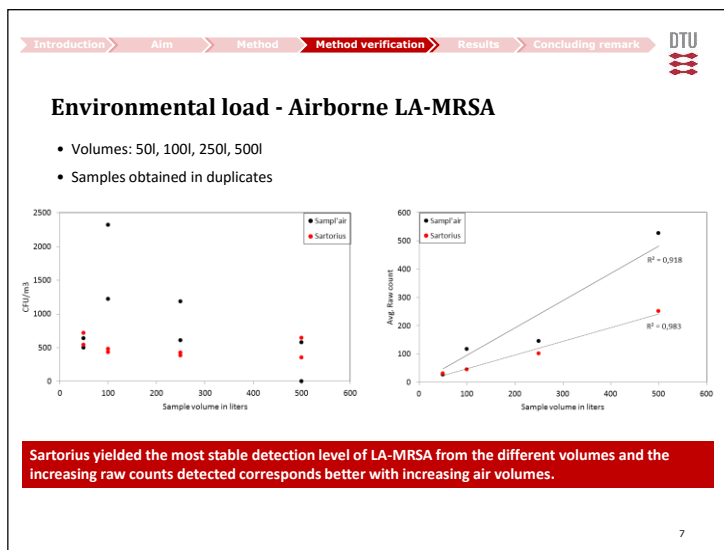
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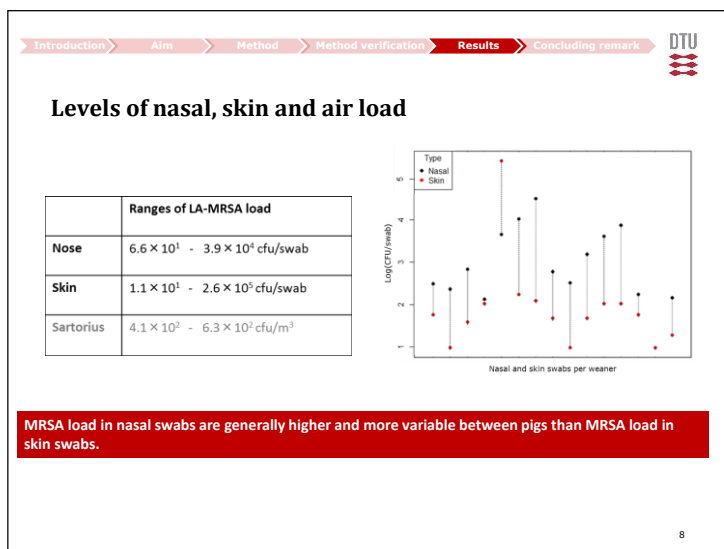
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Introduction > Aim > Method > Method verification > **Results** > Concluding remark

**Animal loads – farm level**

	Sows	Gilts	Pregnant	Farrowing	Weaning	Slaughter	Farm range		Farm avg.	Prevalance
							Lower	Upper		
Farm 1				1,42E+04	4,15E+04	1,89E+03	5,00E+00	7,00E+05	1,79E+04	62/64 (97%)
Farm 2		5,70E+01	5,51E+01	4,41E+02	4,48E+03		5,00E+00	2,80E+04	1,34E+03	60/62 (97%)
Farm 3				3,83E+03	4,33E+03		6,60E+01	3,00E+04	4,13E+03	25/25 (100%)
Farm 4				1,70E+02	2,90E+02	6,43E+00	5,00E+00	1,90E+03	1,49E+02	35/43 (83%)
Farm 5	1,00E+01	5,00E+00		7,50E+00	4,44E+02		5,00E+00	1,87E+03	2,40E+02	17/41 (41%)

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Introduction
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## Concluding remarks

- Quantification of animal LA-MRSA load is possible by direct plating
- Measurements of airborne LA-MRSA load are more stable from Sartorius MD8 air sampler than Sampl'air
- Limitations
  - Contaminant growth can interfere
  - Difficult to standardize
  - Air level as a time point measurement
- Benefits
  - Societal knowledge and demystification of "swine-MRSA"
  - We hope to be able to reduce or hinder the amount of LA-MRSA that escapes the farm
  - Provide knowledge for the authorities to base their decision-making on

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## Acknowledgement

Main supervisor  
Karl Pedersen (DTU Vet)

Co-supervisors  
Anders Rhod Larsen (SSI)  
Ulrike Lyhs (DTU Vet)

<u>DTU Vet</u> Anna Irene Vedel Sørensen Nils Toft Margrethe Carlsen Kári Karbech Mouritsen	<u>SSI</u> Robert Leo Skov Jesper Larsen Øystein Angen	<u>University of Copenhagen</u> Carmen Espinosa-Gongora
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National Veterinary Institute

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SERUM  
INSTITUT

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Can we reduce MRSA ST398 in positive farms by eliminating a few pig carriers?

By Carmen Espinosa Gongora, Post doc., Department of Veterinary Disease Biology, University of Copenhagen

UNIVERSITY OF COPENHAGEN

Faculty of Health and Medical Sciences

**CAN WE REDUCE MRSA ST398 LEVELS IN THE FARM BY REDUCING A FEW PIG CARRIERS?**

CPH PIG SYMPOSIUM Feb 2016

CARMEN ESPINOSA-GONGORA  
ceg@sund.ku.dk

Department of Veterinary Disease Biology  
Faculty of Health and Medical Sciences – University of Copenhagen

I CPH Pig




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PIG STAPH


**Animal Genetics, Bioinformatics and Breeding**

Merete Fredholm  
Claus B. Jørgensen  
Per Skallerup



**Veterinary Disease Biology**

Luca Guardabassi  
Carmen Espinosa-Gongora




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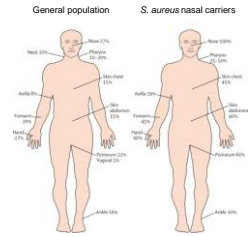
**STAPHYLOCOCCUS AUREUS COLONIZATION**

**Commensal – Carriage/colonization**

- 20% persistent carriers
- 30% intermittent carriers
- 50% non-carriers

**Factors?**

- Bacterial
- Host – Genetic – IR – Microbiota – Environment



80% PEOPLE WITH SKIN INFECTIONS WERE CARRIERS

65% INFECTIONS caused by COLONIZING STRAIN

Wertheim et al, Lancet 2005

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### THE PROBLEM OF MRSA IN PIG FARMING I

**the guardian**

**MRSA superbug found in supermarket pork raises alarm over farming risks**

The discovery of MRSA in supermarket pork has raised concerns over the use of antibiotics in farming.

Philo Huxley, Mark Carter, Maggie Whelan and Andrew Wainwright

Science, 4 June 2013 at 12:01

Pork and by-product (bacon) from a supermarket has been found to be contaminated with a strain of MRSA that is linked to the treatment of livestock. The discovery has raised concerns over the use of antibiotics in farming.

MRSA in pork: farming leaders join calls for clampdown on illegal antibiotics use

British Pig Association calls for government action to clamp down on illegal antibiotic use.

Photo: Getty Images/Chris Wedel

**nature**

**Pigmanure fertilizer linked to human MRSA infections**

Using manure from pigs and manure-treated fertilizers associated with higher rates of antibiotic resistance.

David Sherry

16 September 2013

Photo: Shutterstock

**FORBRUG & LIV**

**Tusindvis er smittet med svine-MRSA uden at vide det**

Op mod 25.000 danskere er smittet med svine-MRSA uden at vide det.

Photo: Shutterstock

**FORBRUG & LIV**

**Svine-MRSA koster endnu en person livet**

En patient er død som følge af en infektion med svine-MRSA.

Photo: Shutterstock

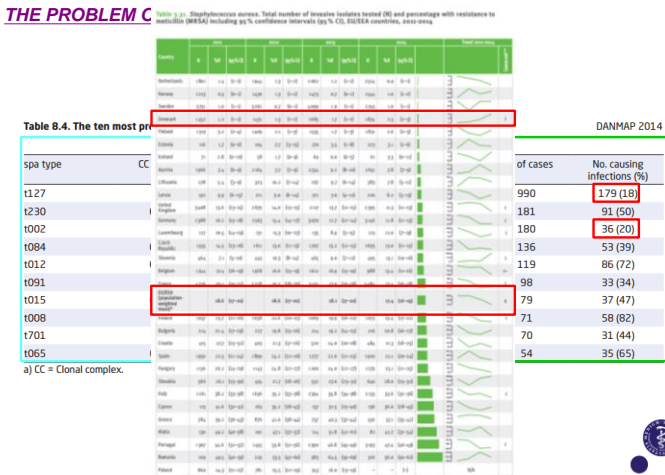
**FORBRUG & LIV**

**Snart kan vi dø af simple bakterieinfektioner**

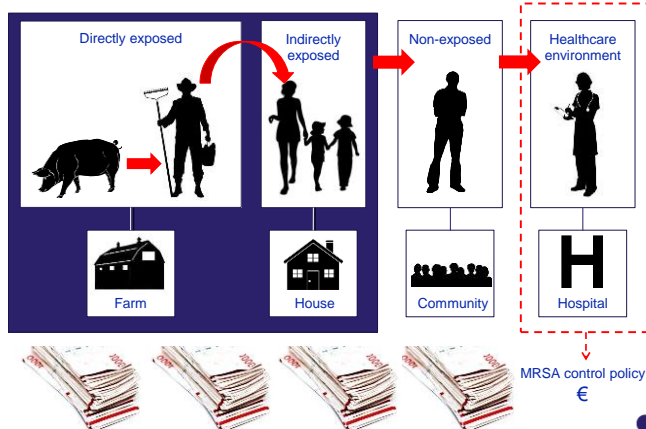
Antibiotika-resistente bakterier gør det svært at behandle almindelige infektioner. Hvis man ikke får behandling, kan det være dødeligt.

Photo: Shutterstock

### THE PROBLEM C

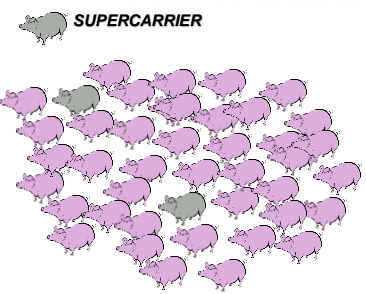


### THE PROBLEM OF MRSA IN PIG FARMING III



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**SUPERCARRIERS** **PIG STAPH**



**SUPERCARRIER**

A minority of the pigs (4-11%) are **"SUPERCARRIERS"** characterized by a high amounts and stable carriage of *S. aureus* in the nose

Espinosa-Gongora et al. 2015 *Appl. Env. Microbiol.*

ARE HOST GENETICS INVOLVED AS A CARRIAGE FACTOR?

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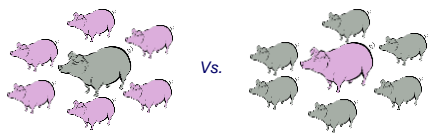
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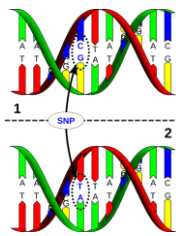
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**SUPERCARRIERS** **PIG STAPH**

ARE HOST GENETICS INVOLVED AS A CARRIAGE FACTOR?



Whole genome sequencing of the pigs

1 SNP 2

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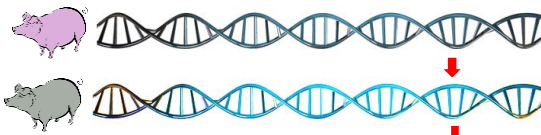
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**GENOME-WIDE ASSOCIATION STUDY (GWAS)**

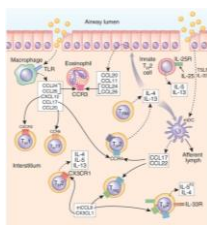
GWAS study using Illumina Porcine SNP60 beadchip (Ramos et al. PLoS one 2009)

➤ Skallerup et al., Genome-wide association study reveals a locus for nasal carriage of *Staphylococcus aureus* in Danish crossbred pigs. *BMC Veterinary Research*



Chemokines  
CCL1  
CCL2  
CCL8  
CCL11

IMMUNE MEDIATORS



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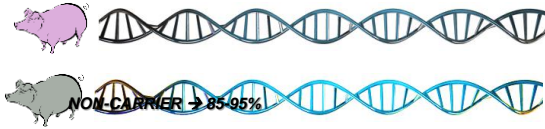
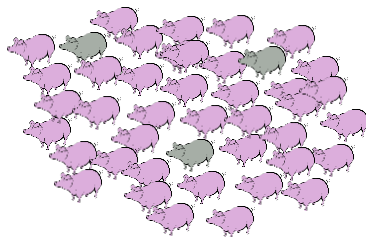
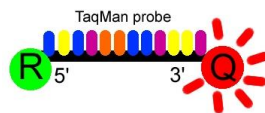
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GWAS study using Illumina Porcine SNP60 beadchip (Ramos et al. PLoS one 2009)

- Skallerup et al., Genome-wide association study reveals a locus for nasal carriage of *Staphylococcus aureus* in Danish crossbred pigs. *BMC Veterinary Research*

**SUPERCARRIER -> 5-15%****RAPID DIAGNOSTIC BY PCR****PIG STAPH****CONCLUSIONS  
&  
FUTURE WORK****PIG STAPH**

- Reducing MRSA levels in pig farms requires **MULTIPLE** measures
- **FARM TRIAL** to test the efficacy of eliminating the *supercarriers*
- **In combination** with more strategies (antimicrobial use? zinc? hygiene? probiotics? disinfection methods? etc...)
- Investigate **functional differences** in the immune response → possible new strategies





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FTP



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Department of Veterinary Disease Biology  
Faculty of Health and Medical Sciences – University of Copenhagen



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## How to pool fecal samples in a cross-sectional study of antimicrobial resistance genes in Danish pig herds

By Anna Camilla Birkegård, PhD student, DTU National Veterinary Institute

DTU

# How to pool fecal samples in a cross-sectional study of antimicrobial resistance genes in Danish pig herds

Julie Clasen, Anders Møllerup, John Elmerdahl Olsen, Øystein Angen, Anders Folkesson, Tariq Halasa, Nils Toft, Anna Camilla Birkegård

DTU Vet  
National Veterinary Institute

$$P_{\pi} = \frac{AP+Sp-1}{Se+Sp-1} \int_a^b \epsilon \Theta^{\sqrt{17}} + \Omega \int \delta e^{i\pi} = \{2.7182818284\}$$

$\Delta$  $\int_a^b$  $\epsilon$  $\Theta$  $^{\sqrt{17}}$  $+$  $\Omega$  $\int$  $\delta$  $e^{i\pi}$  $=$  $\{2.7182818284\}$  $\chi^2$  $\Sigma$  $!$

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## Why?

- Level of zoonotic antimicrobial resistance genes in Danish pig herds
- Cross-sectional study
  - 500-800 herds
  - Spatial randomness
  - Short sample period

Technical University of Denmark

Vet

I ❤️ CPD Pig

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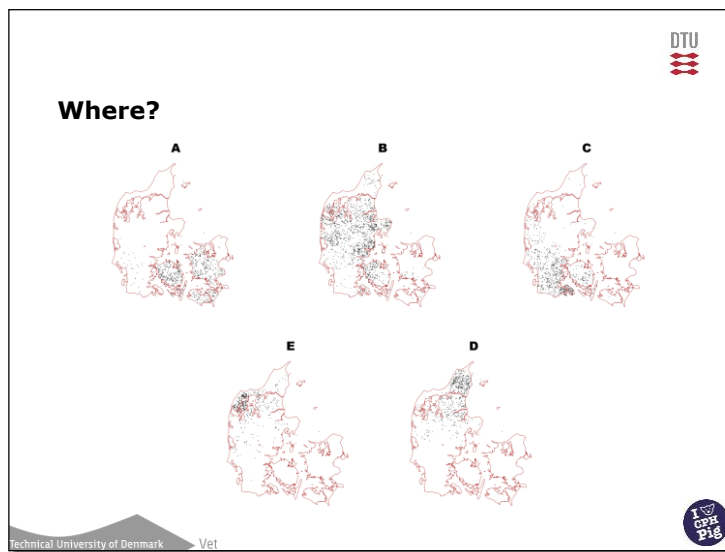
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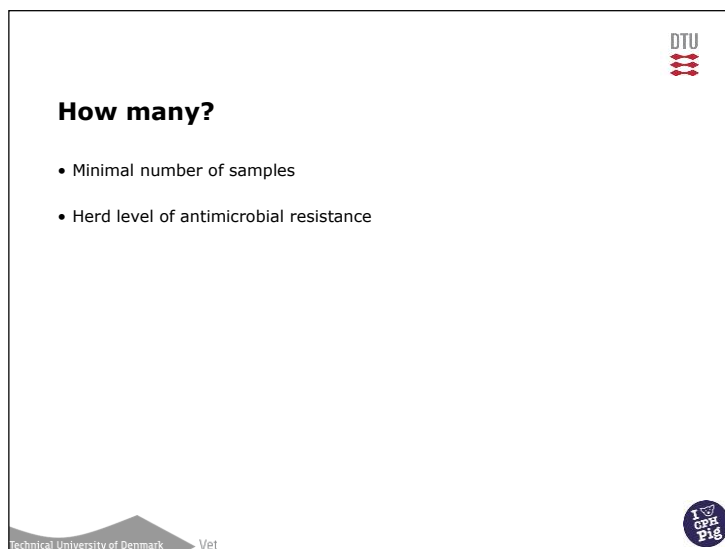
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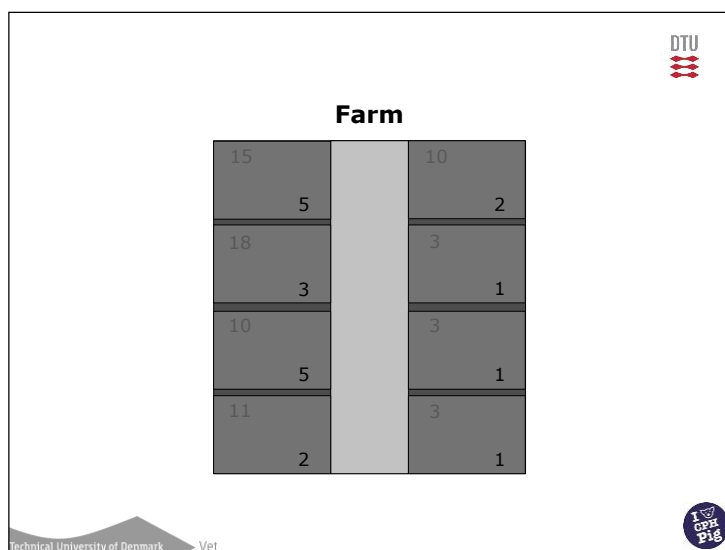
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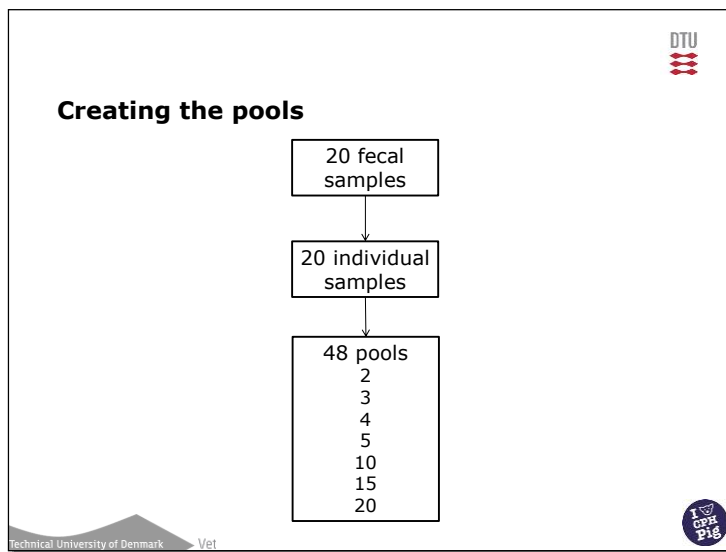
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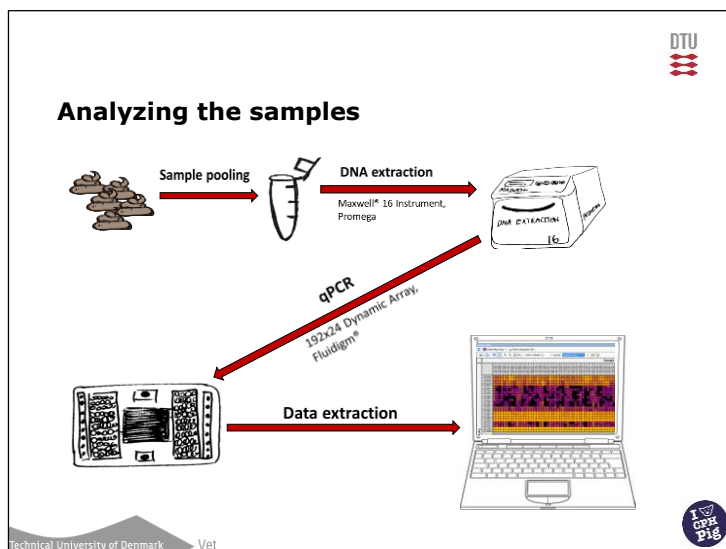
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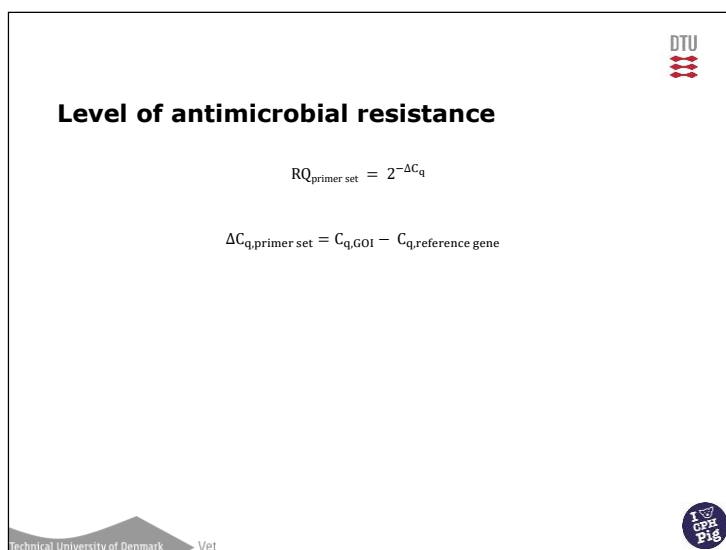
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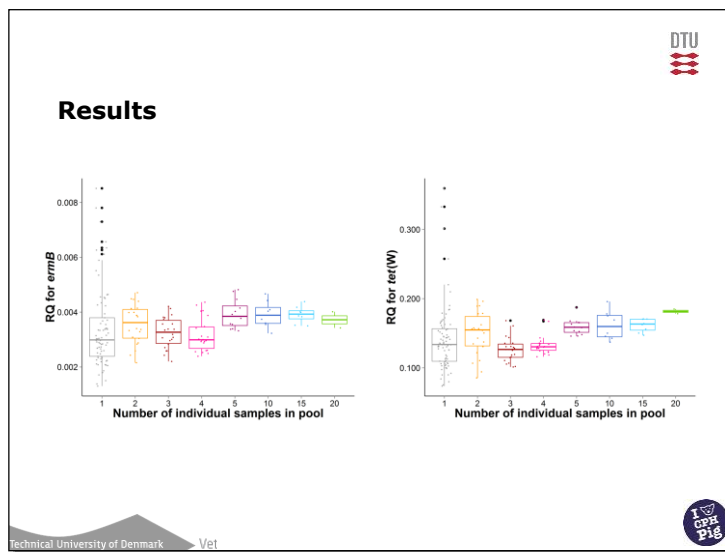
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## Optimizing the pooling method

- 5 herds
- 5 samples per herd
- 3 pooling methods
- 10 pools for method 1 and 2
- 5 pools for method 3

Technical University of Denmark Vet

DTU  
CPH  
Pig

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## Pooling methods

- 1
  - a 1 g 9 mL
  - b 0.5 mL x pool size
- 2
  - a x pool size
  - b x mL
  - c x mL 10 %
- 3
  - a x pool size + 3.5 mL

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CPH  
Pig

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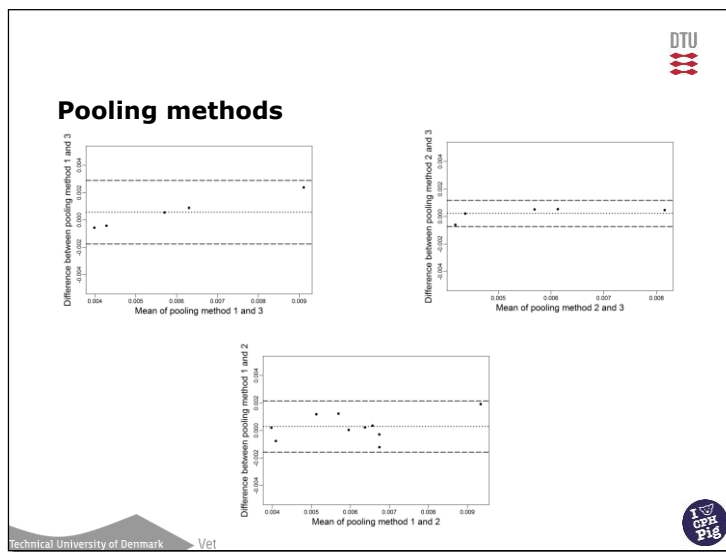
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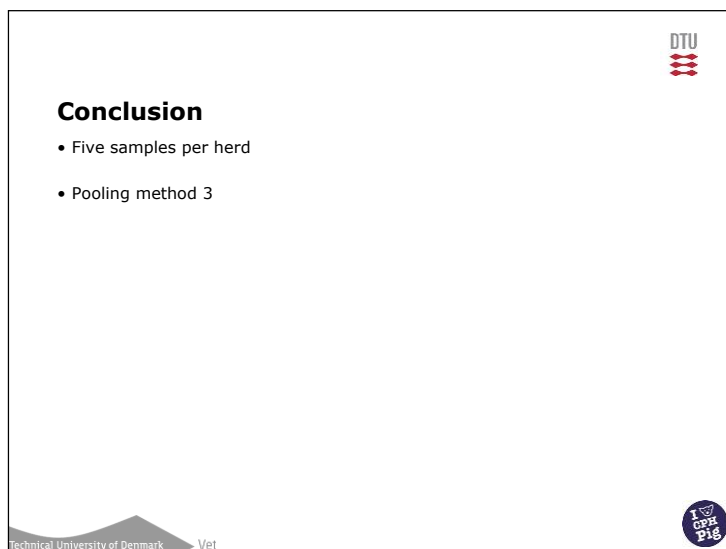
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Can pooled faecal samples be used for resistance profiling? -Resistance in  
E. coli isolates from diarrhoeic nursery pigs

By Nicolai Weber, PhD student, Department of Large Animal Sciences,  
University of Copenhagen

UNIVERSITY OF COPENHAGEN Department of Large Animal Sciences

Faculty of Health and Medical Sciences

**HERD** Can pooled faecal samples be used for resistance profiling?

-Resistance in *E. coli* isolates from diarrhoeic nursery pigs

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Department of Large Animal Sciences,  
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I CPH Pig

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Dias 2

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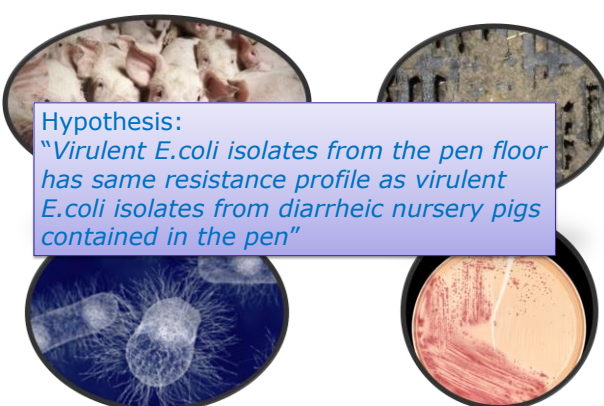
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**Hypothesis:**  
"Virulent *E. coli* isolates from the pen floor has same resistance profile as virulent *E. coli* isolates from diarrheic nursery pigs contained in the pen"

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## Motivation

Development of diagnostic decision tool for selection of antibiotic classes for treatment of *E. coli* diarrhoea



## Supervisors:

Jens Peter Nielsen (Professor, DVM, PhD, Dipl. ECPHM)

Christian Fink Hansen (Associated Professor, MSc Animal Science, PhD)

Ken Steen Pedersen (CEO OE-Vet A/S, DVM, PhD, Dipl. ECPHM)



DTU Vet  
National Veterinary Institute



Dias 4

## Study design

### Pig samples



- 3 nursery facilities
- In pens with >25 % diarrhoea
- 3 diarrheic pigs per pen

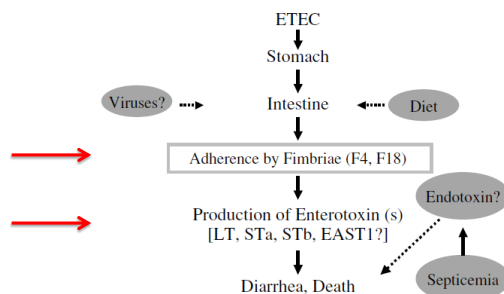
### Pen samples



- 1 pen floor sample

Dias 5

## Pathogenesis





**Definition:** Virulent *E. coli* = fimbriae positive and toxin positive

Dias 6

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### Study design


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Comparison of resistance status at pen level

Hypotheses: Res.Pen = Res.pig

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### Results

89 virulent isolates analysed – all F18 positive  
87/89 hemolytic activity



22/86 sampled pigs



13/31 sampled pens

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Dias 8

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### Results

Antimicrobial class	Overall resistance		Clinical breakpoint (µg/ml)
	% resistant	DTU-VET 06-08*	
<b># Isolates</b>	<b>89</b>	<b>55</b>	
Tetracycline	47.2	69.1	16
Ampicillin	60.7	34.5	32
Sulphamethoxazole	69.7	70.9	512
Trimethoprim	69.7	36.4	16
Streptomycin	34.8	83.6	32
Spectinomycin	18.0	56.4	128

Resistance profiles analysed by Sensititre system  
\* From the national guidelines of antibiotic use

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Results

	Herd 1	Herd 2	Herd 3
<b>Isolates analysed</b>	<b>42</b>	<b>25</b>	<b>22</b>
Tetracycline	100	0	0
Ampicillin	33.3	84	86.4
Sulphamethoxazole	97.6	84	0
Trimethoprim	97.6	84	0
Streptomycin	43	52	0
Spectinomycin	38.1	0	0

Dias 10



Dias 10

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## Results

### Agreement study:

#### Definitions:

**Res.pig** = 1 or more virulent E.coli isolates from 1 or more pigs for the pen

**Res.pen** = 1 or more virulent E.coli isolates from 1 pooled pen floor sample

Dias 11

The logo of the University of Copenhagen, featuring a circular emblem with a question mark and a caduceus-like symbol, surrounded by text.

Dias 11

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Results

		Pig level		Total
		+ Virulent	- Virulent	
Pen level	+ Virulent	10	3	13
	- Virulent	2	16	18
Total		12	19	31

Sensitivity = 83.3 %; Specificity= 84.2 %

PPV = 76.9 %; NPV = 88.9 %



Dias 12

Sensitivity = 83.3 %; Specificity= 84.2 %  
PPV = 76.9 %; NPV = 88.9 %

Dias 12

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### Results

Agreement of resistance	
Antimicrobial class	Agreement
Tetracycline	10/10
Ampicilline	10/10
Sulphamethoxazole	10/10
Trimethoprim	10/10
Streptomycin	10/10
Spectinomycin	8/10

Comparison of Res.pen and Res.pig was only possible i 10 pens

Dias 13

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### Conclusion

- 10 of 31 pens virulent *E.coli* isolated in pen and pig
- Highest prevalence of resistance to Sulpha, TMP and Tetra
- Herd specific resistance patterns
- Excellent agreement between pen resistance and pig resistance
- Low sample size
- Confirmation in larger study needed

Dias 14

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Dias 15

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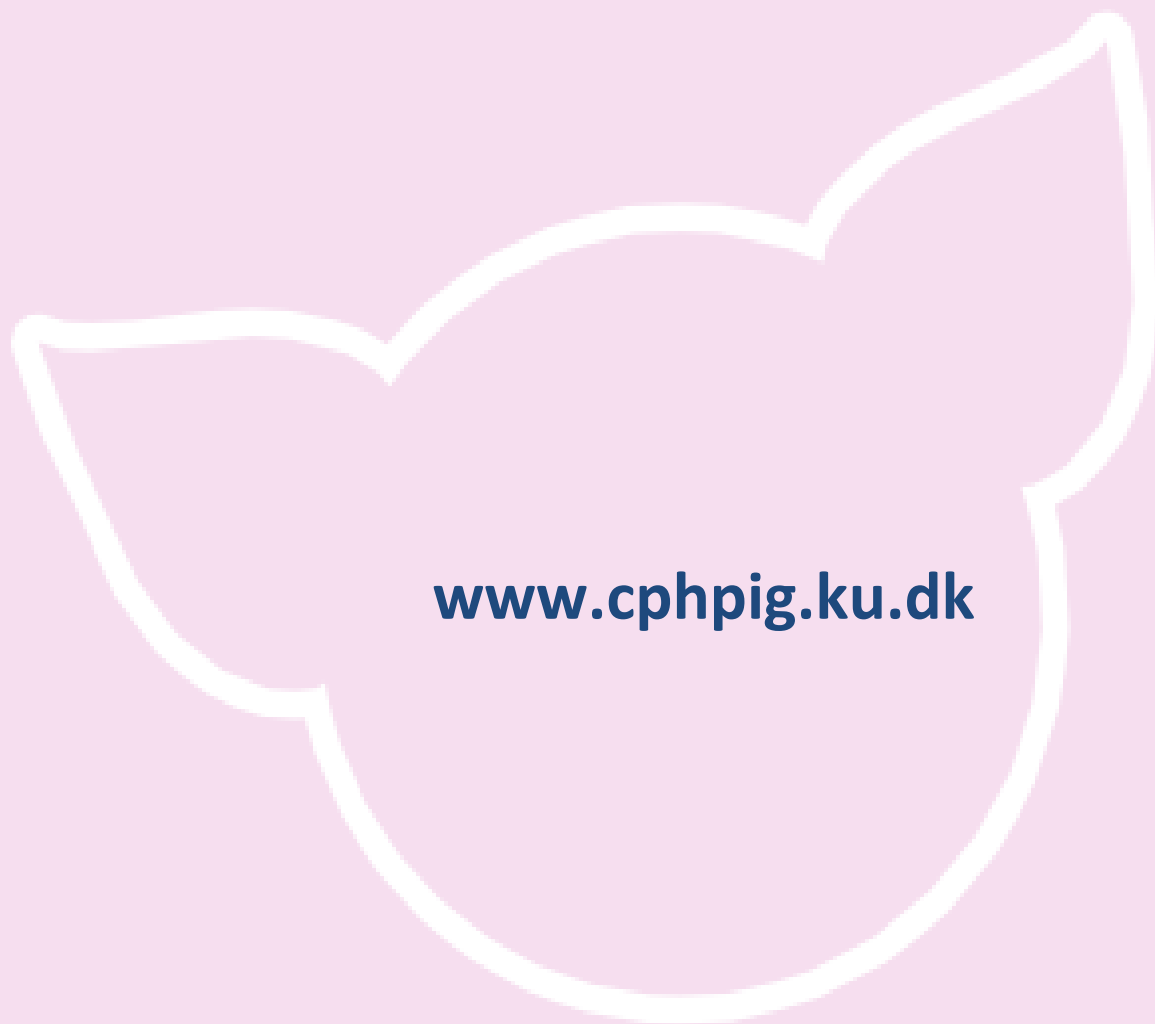
CPH Pig is financially supported by the Pig Levy  
Fund (Svineafgiftsfonden)



[www.svineafgiftsfonden.dk](http://www.svineafgiftsfonden.dk)

Thank you for participating  
– see you next year!





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